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THE STERILIZATION OF INFECTED WOUNDS AND CHRONIC ULCERATIONS BY PERIARTERIAL SYMPATHECTOMY*

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AND

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FROM THE SURGICAL CLINIC OF THE UNIVERSITÉ DE STRASBOURG

ONE usually finds that peri-arterial sympathectomy is followed by an extraordinarily quick healing of refractory ulcerations and torpid wounds.

In the course of our study of the physiological conditions of that healing process, we have observed a fact which seems to us worthy of consideration. Within a few days, sympathectomy is followed by an absolute sterilization of chronically infected wounds, being given, of course, that these wounds are not in contact with foci of osteitis or that they do not contain foreign bodies.

In order not to let any vital point of that phenomenon escape, we proceeded in the following way: The day preceding the operation, we determined on a slide the cytological aspect of the wound or we made a biopsy at that level. We then rubbed the ulceration and sowed a medium gelose-blood in a box of Petri. The same research was made at various intervals after sympathectomy, usually from the fifth day on till the tenth. The bacteriological culture was made in Professor Borrel's laboratory at the

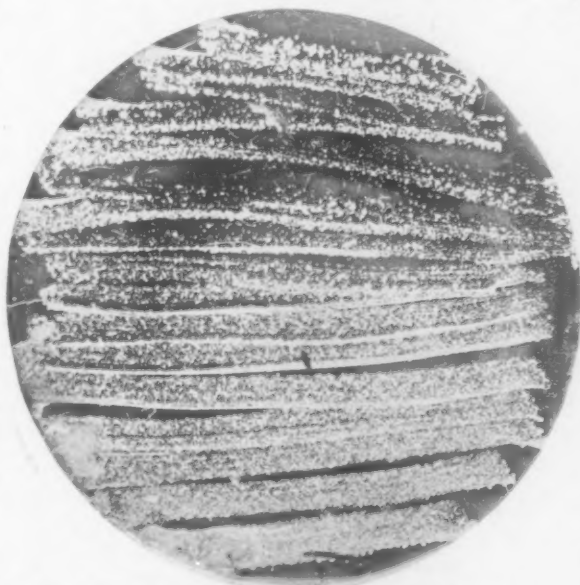


FIG. 1.—Photograph of blood-agar plate inoculated with a swab from the exudate of a chronic leg ulcer. The first culture made on January 30, shows numerous colonies, the counting of these colonies being impossible. Examination of these colonies shows, in order of frequency: staphylococci, Gram-negative diplococci, staphylococci epidermis albus, mixed with streptococci. The patient had the ulcer for sixteen months and had been treated without results, with local applications of Bouillon culture, ultra-violet rays, heliotherapy, injections of énésol and insuline.

* Translated by J. Verbrugge-Anvers.



FIG. 2.—Photograph of blood-agar plate inoculated with a swab from the exudate of a chronic leg ulcer. The second culture was made February 3, forty-eight hours after femoral sympathectomy. The culture showed pure staphylococci. The number of colonies was about one-third less than the previous number.



FIG. 3.—Photograph of blood-agar plate inoculated with a swab from the exudate of a chronic leg ulcer. The third culture was made on February 9, eight days after sympathectomy. Colonies very sparse. They have disappeared toward the middle of the plate. Not more than seventy could be counted. At the same time, the surface of the ulcer was clean, without secretion, granulating, and had become smaller by a third.

WOUND STERILIZATION BY PERIARTERIAL SYMPATHECTOMY

Faculté de Strasbourg. At the proper time, the isolation and the identification of the germs were made. Professor Borrel's advice was resorted to at different times, so that the work was done under the most secure conditions of collaboration.

Proceeding in that way, the following facts were established:

First Fact.—A chronic ulceration (ulcer consecutive to a burn; varicose ulcers; syphilitic ulcers; chronic post-traumatic ulcers, etc.), is always infected to infinity by a large variety of microbial species (staphylococci; streptococci; micrococci candidans; bacilli cuti communi). The depth of the



FIG. 4.—Smear from a chronic ulcer of leg. Before sympathectomy. Smear made on January 28, before sympathectomy. Stained with thionine. Innumerable organisms in a thick bed of fibrin.

wound, that grayish, sanious, well-known depth, is made up of thick layers of fibrin, in which the germs are found. The different dressings which are usually done in those cases do not alter that flora, even if they have no effect on the healing; we may say at least that we have not found after their use any modification worth while mentioning. Arsenobenzol, for instance, even if it brings about the cure of the ulceration, does not modify the bacteriological state of the wound. In the same way, powdered insulin, used following Ambard's method, although so often enticing the healing, did not help us from a bacteriological point of view.

Second Fact.—Soon after sympathectomy, the depth of the wound deterges itself: within a few days, it becomes red, covered with good-looking granulations and quickly diminishes in surface. To these well-known

modifications, corresponds a very quick disappearance of the fibrinous layer referred to above. From the third or fourth day on, we only find on the slides polymorphonuclear cells containing a great number of phagocytosed germs. There are almost no more free germs. Generally, from the fifth

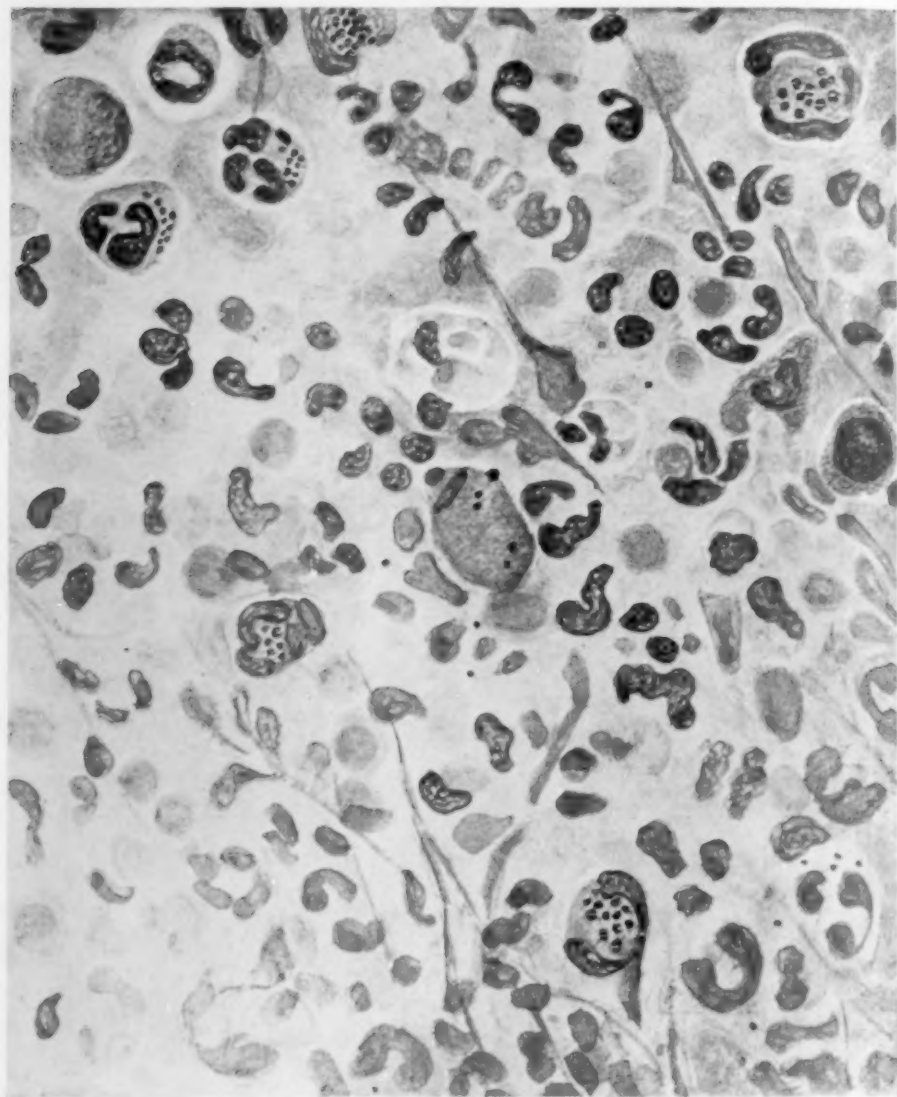


FIG. 5.—Smear from a chronic ulcer of leg. Two days after sympathectomy. Smear made forty-eight hours after sympathectomy. The organisms for the greater part are intracellular. Leucocytes are quite numerous. Fibrin has disappeared.

day on, this is very noticeable. On cut section, taken from biopsies, it also is usually so.

Third Fact.—From the fifth to the thirteenth day, the absence of germs in the wound is a constant fact. The latter is practically and bacteriologically sterile. There are no more microbes, neither on direct examination, nor by

WOUND STERILIZATION BY PERIARTERIAL SYMPATHECTOMY

the culture. One might hardly mention that, from time to time, the culture exhibits rare colonies of germs without significance.

Besides, the slides only show numerous polymorphonuclear leucocytes in good conditions and normal large mononuclear ones.

To What is Due this Quick Sterilization?—It may be explained by a considerable afflux of leucocytes at the level of the ulcer. Indeed, if one

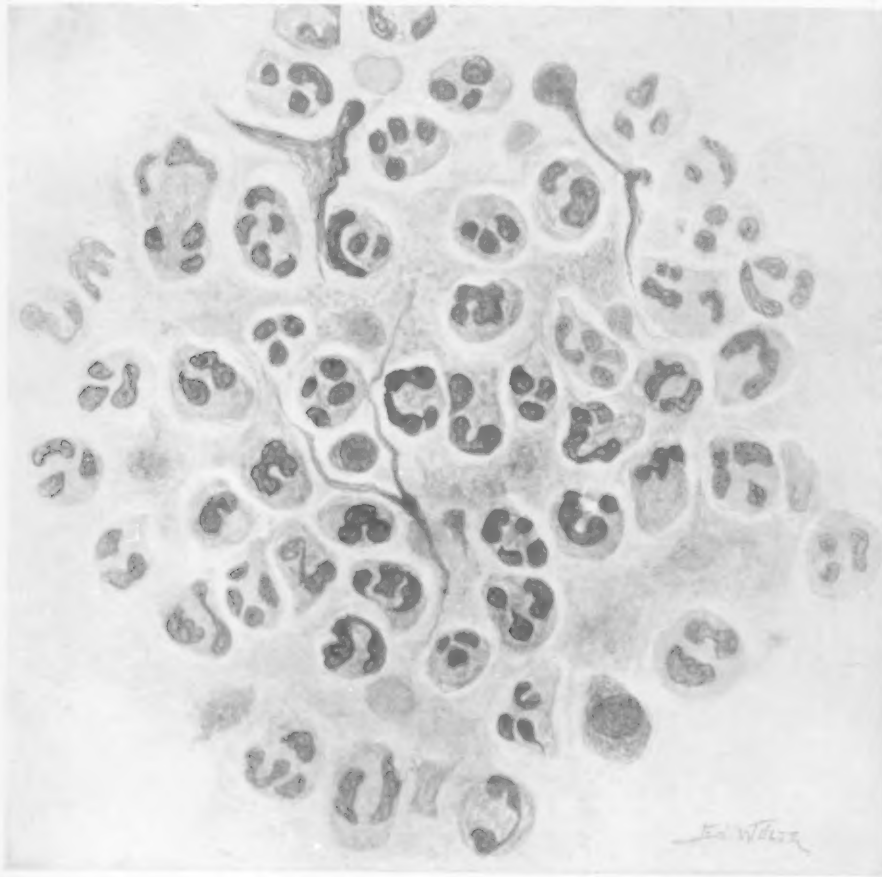


FIG. 6.—Smear from a chronic ulcer of leg. Smear made eight days after sympathectomy. There are only present intact leucocytes. The organisms have nearly all disappeared. Surface of ulcer is sterile.

studies the modifications of the blood following operations on the sympathetic system, one notices that, in parallel lines to the establishment of an active hyperæmia, an increase in the number of leucocytes and a marked predominance of polymorphonuclear cells take place. This increase in the number of leucocytes and red blood-cells is found as well after operations on the periarterial sympathetic system as on the cervical sympathetic chain. It does not last as long after peri-arterial sympathectomy, as it may be easily understood.

Moreover, after this operation, during the period of vaso-constriction, the number of leucocytes and red blood-cells diminishes, whereas the transient

diminution of white and red blood-cells is absent after operations on the chain. Here are a few figures which will illustrate these facts:

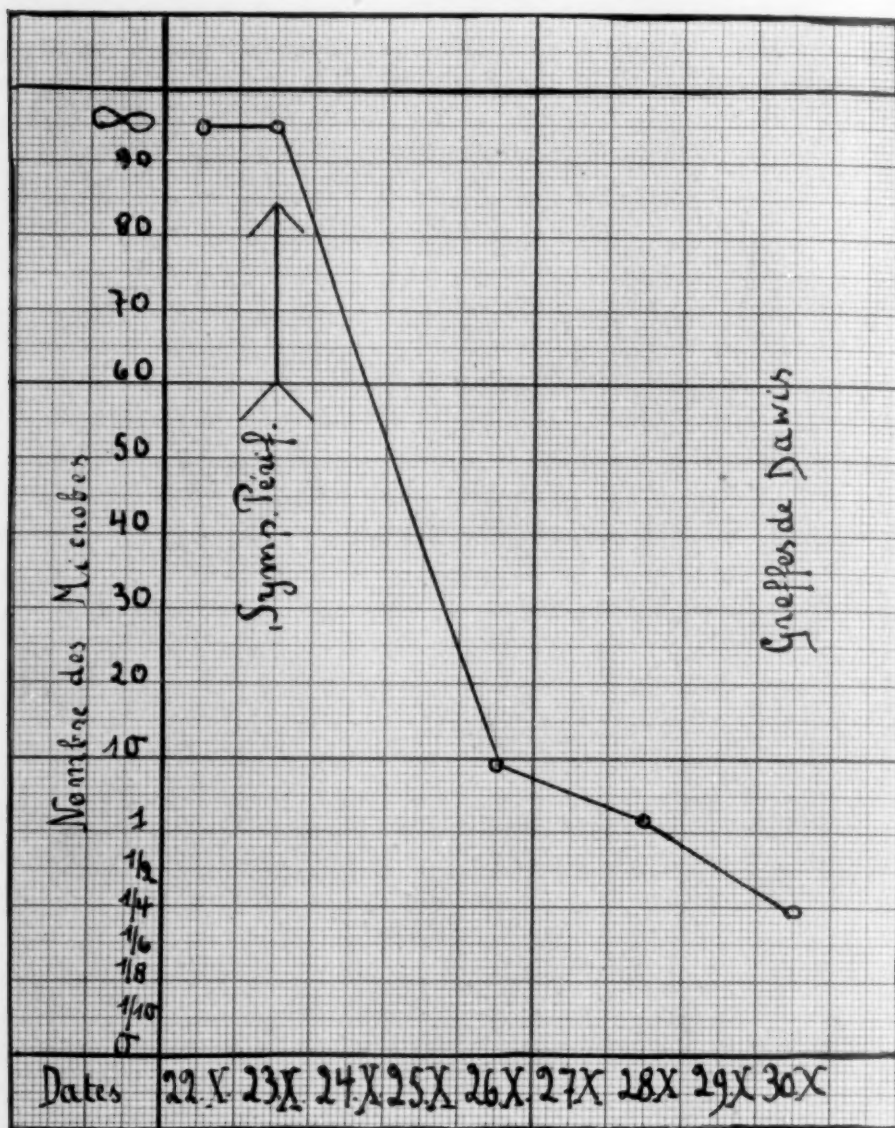


FIG. 7.—Carrel-Graphic showing sterilization of a burning-sore of old standing, without any tendency toward healing (treated for nine months). Skin grafts made on the seventh day; complete healing after twenty-two days. No recurrence five months later.

In one of our patients we had found:

	R. B. C.	Leucocytes
Soon after peri-arterial sympathectomy	5,775,000	9,633
At the end of the operation (during the period of vaso-constriction)	3,810,000	3,876
The day following operation (after establishment of vasodilatation)	6,035,000	9,000

WOUND STERILIZATION BY PERIARTERIAL SYMPATHECTOMY

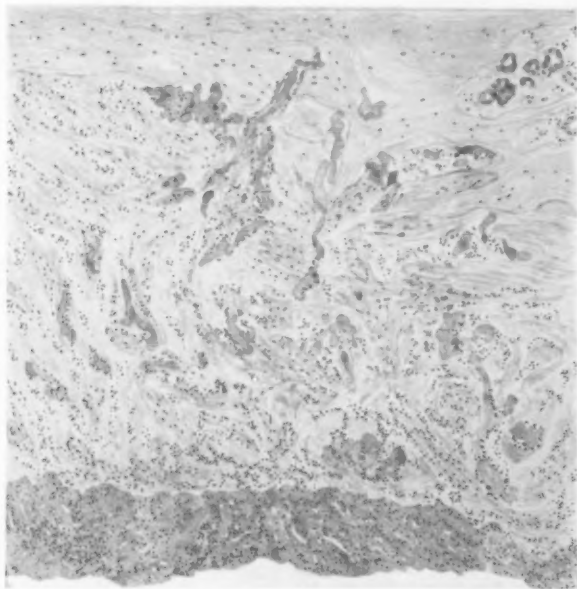


FIG. 8.—Section for microscopic examination, taken from the edge of a leg ulcer, before peritremoral sympathectomy. Low magnification shows the condition before the sympathectomy; a thick deposit of fibrin covers the ulcer and the vessels, for the greater part obliterated. All show a swollen endothelium.

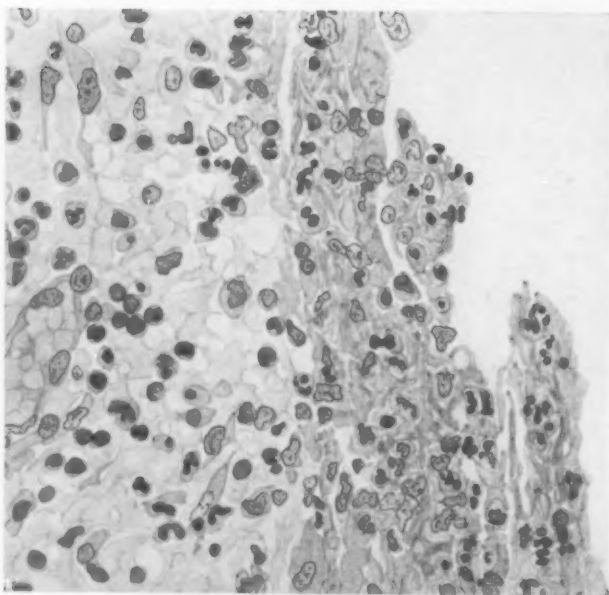


FIG. 9.—Section for microscopic examination, taken from the edge of a leg ulcer, before peritremoral sympathectomy. High magnification shows the condition before sympathectomy; a thick deposit of fibrin covers the ulcer and the vessels, for the greater part obliterated. All show a swollen endothelium.

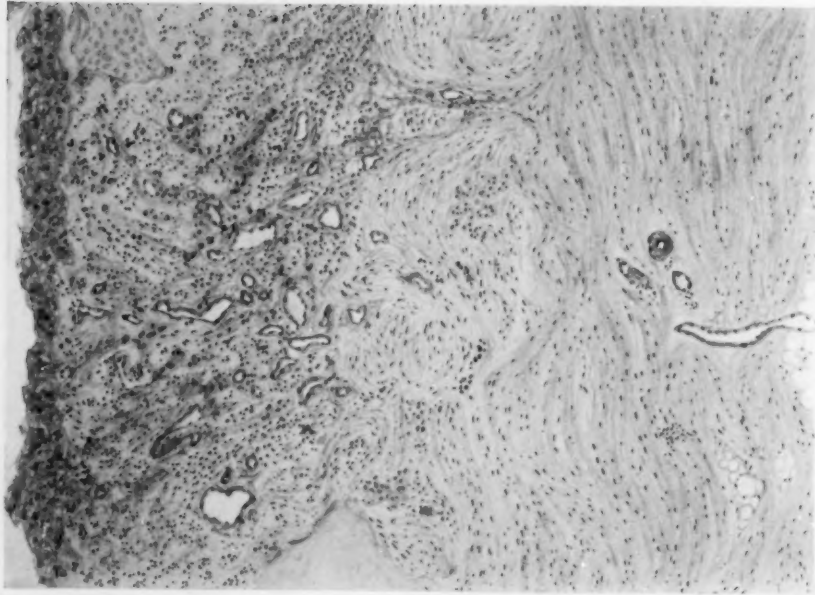


FIG. 11.—Section for microscopic examination, taken from the edge of a leg ulcer, seven days after peritremal sympathectomy. High magnification of section taken seven days after peritremal sympathectomy. A notable diminution in the fibrin layer. The vessels have become permeable. The endothelium is normal. The lesion shows the tendency to become organized like an ordinary granulation tissue.

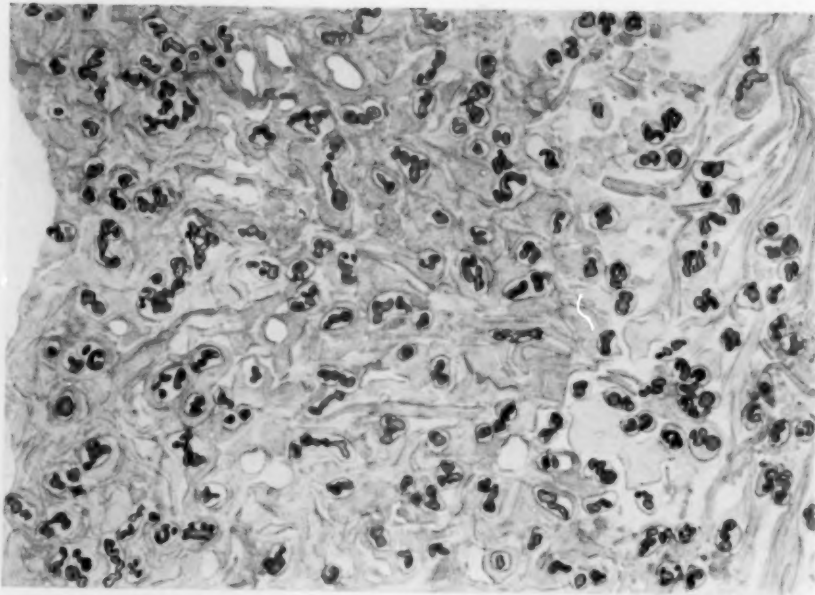


FIG. 10.—Section for microscopic examination taken from the edge of a leg ulcer, seven days after peritremal sympathectomy. Low magnification of section taken seven days after peritremal sympathectomy. A notable diminution in the fibrin layer. The vessels have become permeable. The endothelium is normal. The lesions show the tendency to become organized like an ordinary granulation tissue.

WOUND STERILIZATION BY PERIARTERIAL SYMPATHECTOMY

On the other hand, a patient who had undergone the ablation of the superior cervical ganglion, exhibited the following modifications. (The blood had been taken at the level of the ear.)

	R. B. C.	Leucocytes
Before operation	4,200,000	5,200
After operation (vaso-dilatation already conspicuous).....	6,380,000	19,300
In the evening	5,100,000	8,800

Another patient, who had undergone a simple section of the sympathetic chain, showed the following variations of the leucocytic formula: The cells



FIGS. 12 and 13.—Chronic ulcer in scar tissue following extensive burns. Cure in twenty days by sympathectomy and Davies' grafts. The sympathectomy was performed October 23, 1925. Seven days later, the surface of the ulcer being sterile, the graft was done. On November 15, cicatrization was complete and the patient was allowed to go without a dressing. The patient was again seen on April 19, 1926, well-healed, with the skin in good condition.

which had numbered 6933 before the operation, numbered 11,600 the evening of the operation (while the arm was burning and had become very hot hyperthermia of 3°).

Here are the two corresponding formulas:

	Before op. %	After op. %
Neutrophile leucocytes	76	90.5
Small lymphocytes	12	4
Large lymphocytes	8	2
Mononuclear	1	0
Transitional forms	3	1.5

However, it would not be right to believe that all in the action of sympathectomy is reducible to a sterilization of the infected surfaces. It produces,

besides this sterilization, an exaltation of the tissues' vitality, which makes, that the rapidity of healing of an infected wound exceeds, as we have seen, that of a normal aseptic one, as Carrel and Lecomte de Nouy have estimated it.

But we believe anyway that one should not let the tissues perform all the efforts of reparation in cases of chronic ulcerations of all kinds, at least if the wound has important dimensions.

In chronic ulcerations, three elements play a part as far as their chronicity is concerned: (1) The bad condition of cutaneous circulation; (2) the chronic infection; (3) the existence of a certain loss of skin surface, due to a dermo-epidermic necrosis, probably by superficial arteritis, having started with the accident. Whenever, through the sympathectomy, one has modified the state of skin nutrition and succeeded in fighting the chronic infection, the wound is able to heal by its own power and it often does it satisfactorily. But we believe that we are asking too much from tissues which have been diseased for a long time and which, at the leg, have no suppleness at all. We believe that we are putting the patient in better condition of definite cure by making dermo-epidermic grafts. In that way one cancels the third cause of permanency of chronic ulcerations.

In taking the advantage of the aseptic state brought about by the sympathectomy, one may be sure to see the grafts take well and, in this way, one may very quickly make sure of a complete cure of ulcers dating from ten to fifteen years, the graft being done ten days after the sympathectomy.

The results thus obtained are very encouraging. It must be understood, of course, that we have only applied this method to ulcerations which had previously been treated by antisyphilitic medications and which did not depend on underlying varicose veins. There had only been question of ulcers consecutive to burns, traumas or phlebitis.

CONCERNING INTRACRANIAL MALIGNANT METASTASES*

THEIR FREQUENCY AND THE VALUE OF SURGERY IN THEIR TREATMENT

By FRANCIS C. GRANT, M.D.

OF PHILADELPHIA, PA.

AFTER many years of effort our appreciation of the clinical symptoms indicating the existence of an intracranial tumor has so far improved that it is now possible to state with some assurance whether or not such a lesion is present. Hand in hand with our increased knowledge of the evidence pointing to this diagnosis has come a great advance in the surgical technic involved in dealing with such lesions. It is along surgical lines that the attack on these tumors and the increased intracranial pressure which commonly accompanies them has been made with the greatest degree of success. And as always occurs in dealing with any problem of living pathology it is through this advance in surgical methods of exposing and removing such tumors that our familiarity with them has increased even to the point where prior to operation it is now possible to venture a shrewd guess, often a positive statement, as to their pathological structure and its bearing on the ultimate outcome of the case.

Since, therefore, grouped as a whole surgical extirpation of the neoplasm is indicated under these conditions, it is of course necessary to recognize the fact that there are neoplasms in which surgery offers but little or may even be contra-indicated. Among these lesions are the metastatic tumors. A recent experience with an intracranial metastatic lesion from an unrecognized primary cancer of the lung led to a review of similar cases to determine how effective surgery has been in the handling of malignant metastases to the brain.

The history of this case is as follows:

Operative removal of a large vascular infiltrating tumor of the left fronto-motor area. Decompression. Operative recovery. Microscopic examination proved tumor to be metastatic carcinoma. X-ray disclosed primary growth in upper lobe of left lung.

* From the Surgical Clinic of Dr. Harvey Cushing, Peter Bent Brigham Hospital, Boston, Massachusetts.

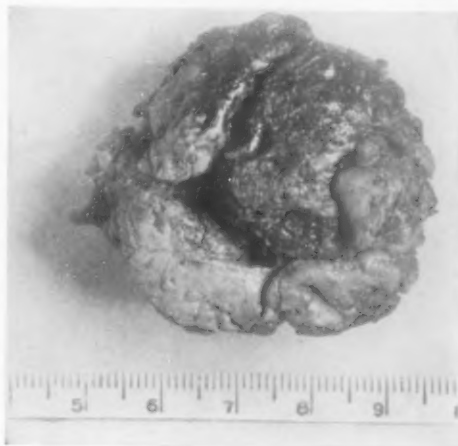


FIG. 1.—Tumor removed from case reported in text. Note that tumor is fairly firm and discrete though unencapsulated.

FRANCIS C. GRANT

April 22, 1925. Admission of Mr. C. D. G., aged fifty-six. Chief complaint: Paresis of right arm and leg, motor aphasia, headache.

Present illness: Patient had been entirely well until March 8, 1925. On this date he had a sudden twitching of the muscles of the right side of his face. This occurred again on March 12. At this time it was noticed that his speech was becoming thick and that he showed a tendency to fumble over words and phrases. Within two weeks a motor aphasia had become pronounced. Weakness of his right face was noted, he was slightly weak in his right hand and a right-sided clonus and Babinski sign appeared. There was no evidence of intracranial pressure. The diagnosis lay between a vascular lesion and tumor. A left cerebral exploration was performed elsewhere March 28 with negative findings. Following this procedure his motor aphasia became complete.

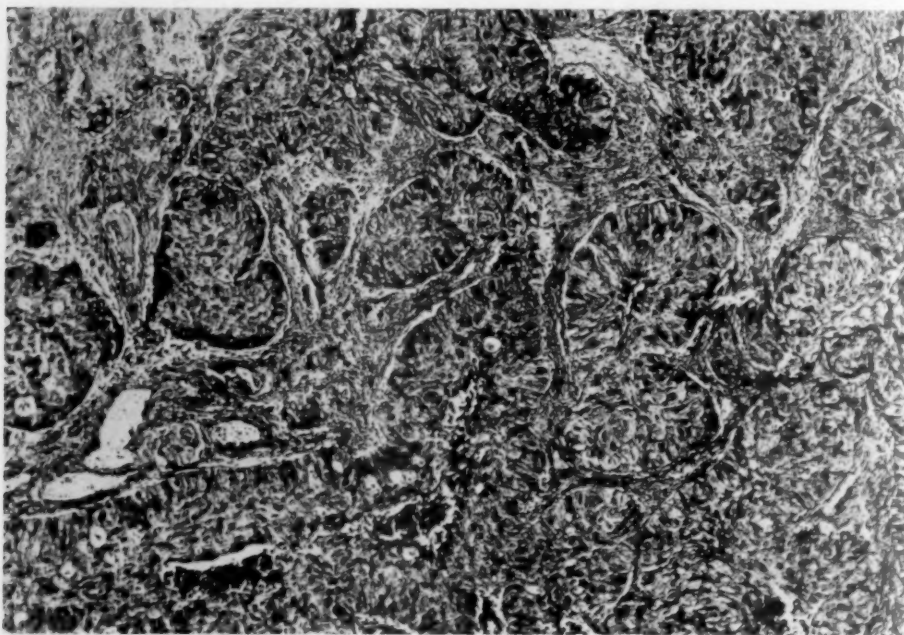


FIG. 2.—Photomicrograph of tumor shown in Fig. 1. Low power H. and E. stain.

A left-sided weakness in face and extremities with sensory hypæsthesia developed. He recovered somewhat from this condition before his admission to this hospital.

Physical examination on admission was essentially negative except for the neurological findings outlined. It is stated specifically that the lungs showed no abnormal physical findings. No evidence of intracranial pressure present. X-rays of the skull showed the pineal shifted to the right suggesting a left-sided tumor. As the case seemed obscure and the tumor if present probably deep-seated, intensive X-ray treatments were given. Just prior to his discharge he had a generalized convulsion beginning in the right side of the face and accompanied for the first time by unconsciousness.

On June 25, 1925, about six weeks after his discharge, he was re-admitted. For a month his condition had continued to improve appreciably, but two weeks prior to this date he had had two generalized convulsions with unconsciousness. Since that time he had rapidly deteriorated, his motor aphasia again became complete, and the paresis of his right extremities increased to paralysis with spasticity. He was semi-comatose and incontinent. The right extremities were spastic and paralytic with increased reflexes, Babinski and a bilateral clonus. A bilateral papillitis with fresh exudate and hemorrhages were recorded.

INTRACRANIAL MALIGNANT METASTASES

In view of the progression of symptoms and desperate condition, Doctor Cushing reelevated the old flap and identified and extirpated a large vascular tumor lying in the left fronto-motor area which was thought to be a glioma.

The patient made an excellent operative recovery and by degrees regained his speech, and power in his extremities. The tumor proved unexpectedly on microscopic examination to be a metastatic carcinoma, probably, from its structure, primary in the lungs. An X-ray study of the chest revealed a large round tumor in the left upper lobe. After X-ray therapy of the tumor sites in the cranium and chest, he was discharged much improved, and continued to improve for the next four months. On

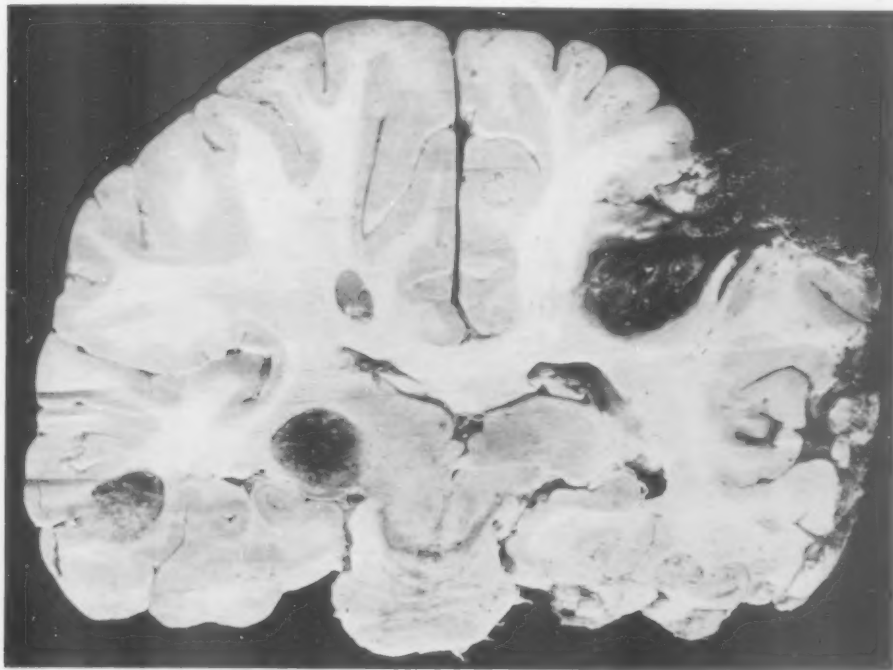


FIG. 3.—Coronal section of brain. Shows multiple carcinomatous metastases throughout cerebral hemispheres. Primary focus in breast.

October 11, 1925, he had a sudden severe general convulsion from which he never fully regained consciousness and he died two weeks later.

That this patient had a metastatic lesion from a primary cancer of the lung was entirely unsuspected. As noted by Craver¹ the diagnosis of pulmonary cancer is rarely made on physical signs alone. Unusually as in this case it is an accidental X-ray finding. Certainly nothing was brought out in the history or by the routine examination to cast suspicion on the chest. Moreover a detailed thoracic examination after the tumor had been radiographically disclosed failed to reveal any physical signs which would have shown its presence even had it been suspected.

But even had the primary tumor in the lungs been disclosed, would operation have been contra-indicated. The prognosis of course would have been utterly bad. But here was a patient with headache, choked disc and other signs of pressure. He was a man of large affairs, cut down in his prime to

whom relief of symptoms, even for a short time, would mean much. A left subtemporal decompression, or as was carried out, a flap with decompression might, as it did, reveal a pathological condition which could be handled. At least pressure symptoms might be relieved. Deep X-ray therapy might have ameliorated his condition, but it had been attempted without avail. Decompression to relieve pressure and to permit of more effective X-ray treatment was indicated in any event. As the patient had already had a flap turned



FIG. 4.—Low power photomicrograph showing multiple metastases in brain shown in Fig. 3. $\times 80$. H. and E. stain.

back, its reëlevation was simple. If a similar case appears for treatment it will doubtless be handled in the same fashion. But the clinical history illustrates excellently well the rapidity with which cerebral carcinoma acts and the ultimate hopelessness of the condition even though symptoms may be palliated by surgical measures.

A review of the literature on the occurrence of malignant metastases to the brain gives evidence that this takes place with variable frequency. Krasting² in examining the tissue from 12,730 cases found 1238 (9.8 per cent.) with malignant disease. In this group there were 1078 cases of carcinoma and 160 of sarcoma. In 935 of the 1238 the brain had been examined.

INTRACRANIAL MALIGNANT METASTASES

Of these 817 were carcinomata and 39 (4.7 per cent.) showed a brain metastasis; 118 were sarcomata and 14 (12.4 per cent.) showed a brain metastasis. It is important to emphasize that sarcoma gives a larger percentage of metastases to the brain than does carcinoma, although carcinoma metastases are more frequently encountered since this form of malignant disease is the more common of the two.

Rau³ compiled similar statistics in a series of 10,393 autopsies and identi-

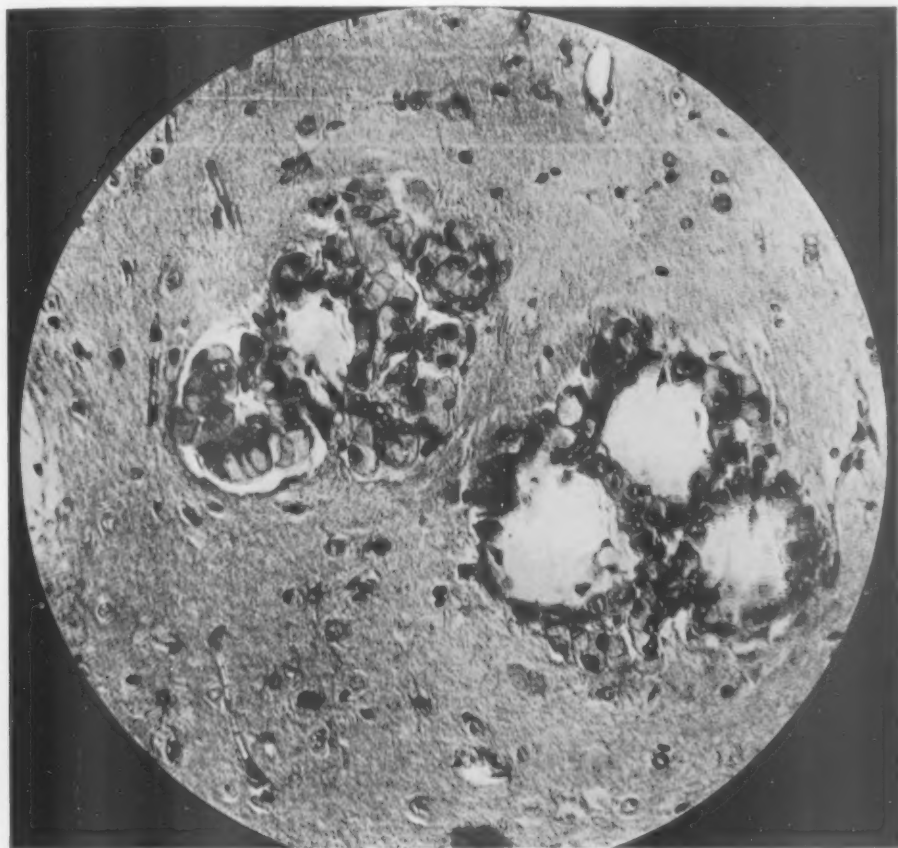


FIG. 5.—High power photomicrograph showing perivascular invasion by carcinoma cells.

fied 1032 examples of carcinoma (10 per cent.) and 90 of sarcoma (0.9 per cent.). Of the carcinoma group 851 had brain sections and 28 (3.2 per cent.) gave evidence of intracranial metastasis, while among the 90 sarcoma cases 68.1 per cent. showed involvement of the brain.

Krasting states on the basis of his own figures and those of Starr,⁴ Gurlt,⁵ and Gallavardin and Varay⁶ that intracranial metastasis follows 18 per cent. of all primary carcinomata. Redlich,⁷ Riechelman,⁸ Feilchenfeld,⁹ Bejach¹⁰ and Berenczy and Wolff¹¹ in large series of cases show a smaller percentage than either Krasting or Rau of malignant metastases to the cranial cavity, due apparently to the fact that the brain was less often examined.

All authorities agree that sarcoma, though less frequent than carcinoma, is more malignant and gives intracranial metastases in a much larger percentage of cases. Malignant neoplasms in certain situations seem to show a definite predilection to metastasize to the brain, but if the primary focus be located elsewhere such metastases are uncommon. Cancer of the stomach, probably the most frequent primary carcinomatous lesion curiously enough is but rarely followed by intracranial involvement. Rau³ found only three such

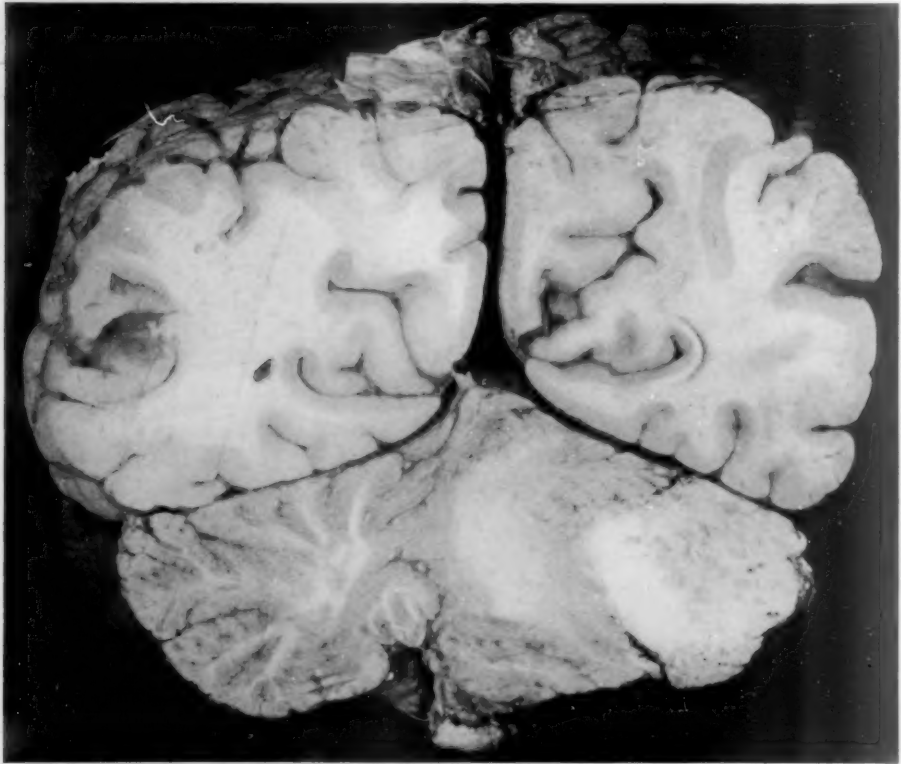


FIG. 6.—Coronal section through cerebral and cerebellar hemispheres, showing a single carcinomatous nodule in cerebellum. Primary focus, probably breast.

metastases in 169 cases of gastric carcinoma. The pulmonary capillaries must act as a great filter for tumor emboli in the blood stream. Once past this barrier the pathway for an intracranial implantation is direct. Hence mammary and pulmonary cancer furnish the highest percentage of secondary growths in the cranial cavity. Among 139 cases of secondary cranial malignancy, Krasting² found that 40 followed mammary and 29 pulmonary cancer. Handley¹² records 16 cerebral metastases among 329 primary malignancies of the breast; Rau⁷ in 72; the Middlesex Hospital Series¹³ 39 in 470 similar lesions. Dosquet¹⁴ found metastases to the central nervous system in 31.4 per cent. of 105 patients with lung cancer.

Krasting states that 50 per cent. of all melanotic sarcomata metastasize to the brain. Rau identified nearly one-half of his reported sarcoma cases

INTRACRANIAL MALIGNANT METASTASES

as of this type. Erwin¹⁵ quotes Westphal and his own cases as showing that but 8 of 131 verified hypernephromata showed cranial metastases.

Secondary malignant metastases develop two types of lesions within the skull. The first and by far the most common is the single or diffusely scattered discrete nodular lesion more frequently subcortical and apparently only involving the surface of the brain by increase in size and extension of growth. It is evident that these metastases must be blood-borne and embolic in origin from the primary growth (Kaufman,¹⁶ Goldman,¹⁷ Siefert,¹⁸ Schmidt,²⁰ and von Recklinghausen²¹). Krasting holds that the relatively greater frequency of left-sided cerebral metastatic lesions over other areas speaks for metastasis through the arterial tree, for the left cerebral hemisphere being more important functionally than the right receives a larger supply of blood, and the amount of blood passing through the cerebrum is relatively greater than through the cerebellum.

There is another much rarer condition of "meningitis or pachymeningitis carcinomatosa" in which the brain tissue itself may be totally free from cancer elements while the dura and pia arachnoid are so infiltrated as to cause serious pressure symptoms. The infiltration may be of the dura only, causing it to appear thickened and hemorrhagic resembling the so-called hemorrhagic internal pachymeningitis (Hassin²²). A diffuse sarcomatosis or melanosis of the cerebral envelopes has also been described (Boyd,²³ Weaver,²⁴ Weller,²⁵ Ford and Firor²⁶), but this is primarily an intracranial lesion and there is some doubt as to whether the term "sarcoma" for the process is properly used.

All the verified cases in this series showed metastases of the first type, nodular and discrete in character, single or multiple, all presumably due to emboli carried in the blood stream from the primary focus. The diffuse involvement of the arachnoid space which occurred in several instances was always accompanied by and probably secondary to a subcortical lesion. As the subcortical focus grew the cells broke into the perivascular space of adjacent blood-vessels and then passed to and infected the subarachnoid space. Or as the metastatic nodule grew it eventually broke into the subarachnoid space by direct extension.

Among the cases admitted to the neurosurgical service of the Peter Bent Brigham Hospital in the thirteen years up to March 1, 1926, 49 were diagnosed as having a metastatic intracranial lesion, 26 of them having been verified at operation or autopsy. Among the 23 histologically unverified cases, the nature of the primary focus or of its glandular metastases had been assured here or elsewhere in all but three instances. In these unverified cases the clinical symptoms pointed so definitely to an intracranial metastasis that in most cases surgical intervention was not recommended. But since microscopic evidence of the nature of the lesion within the brain is lacking, such lesions are classed as unverified.

From an examination of the statistical tables (Table I), based on this series of 49 cases, it will be seen that carcinoma occurs almost twice as

TABLE I.
Intracranial Metastases—Summary

Sarcomata													
Primary malignant focus	Breast	Lung	Mouth and sinuses	Generative organs	Liver and intestines	Primary focus unknown	Total	Skin and retina	Hyper-nephroma	Generative organs	Myeloma	Total	Total all cases
Number of cases	15	6	4	4	2	5	36	7	4	1	1	13	49
Verified	6	6	2	1	1	4	20	3	2	1	0	6	26
Unverified	9	0	2	3	1	1	16	4	2	0	1	7	23
Initial symptoms													
Psychosis	5	4		2		1	12			1		1	13
Headache	9	2	3	3	2	3	22	5	1	1	1	8	30
Vomiting	5	1			1		7	3	1			4	11
Loss of vision	4		1	1		1	7	2	1			3	10
Sensory	4			1		3	8		1			1	9
Motor	5	4	1	2	1		13	3	2			5	18
Average period from initial symptoms to admission to hospital	15 cases, 67 mos. aver. 4½ mos.	6 cases, 21 mos. aver. 3½ mos.	4 cases, 32 mos. aver. 8 mos.	4 cases, 31 mos. aver. 12 mos.	2 cases, 6 mos. aver. 3 mos.	5 cases, 31 mos. aver. 6 mos.	36 cases, 16 mos. aver. 5½ mos.	7 cases, 25 mos. aver. 3½ mos.	4 cases, 16 mos. aver. 4 mos.	1 case, 3 mos.	1 case, 10 mos.	13 cases, 54 mos. aver. 3½ mos.	49 cases, 54 mos. aver. 5½ mos.
Osteoplastic flap	3	5	1	1	1	3	14	3	1			4	18
Decompression	2		1	1		1	5	3	1			4	27
Improved	2	3		1			6	2	2			4	10
Not improved	3	2	2	1	1	4	13	4				4	17
Average period from operation or admission to hospital to death	5 op. cases, 2 op. cases, 2+ aver. 3 mos. 10 mos. 2 unop. cases, 4+ mos. 4+ mos.	5 op. cases, 3 op. cases, 10 mos. 1 unop. case, 3 mos. 3 mos.	2 op. cases, 1 op. case, 1½ mos. 3 op. cases, 1½ mos. 1½ mos.	2 op. cases, 1 op. case, 1½ mos. 3 op. cases, 1½ mos. 4½ mos.	1 op. case, 5 mos. 1 unop. case, 1 mos. 1 mos.	4 op. cases, 1 op. case, 1½ mos. 1 op. case, 2 mos. 1 op. case, 3 mos.	19 op. cases, 3+ aver. 3+ mos. 17 op. cases, 3+ aver. 3+ mos. 3- mos. 17 mos. 3- mos. 3- mos.	6 cases op. aver. 3- mos. 1 unop. case, 17 mos. 7 cases, 3- mos. 17 mos. 3- mos. 17 mos.	1 op. and rec. 1 op. case, 1 unop. case, 2 unop. cases, 4 mos. 4 mos.	1 op. and rec. 1 op. case, 1 unop. case, 2 unop. cases, 4 mos. 4 mos.	1 mo.	7 op. cases, 2+ aver. 2+ mos. 5 unop. cases, 3+ aver. 3+ mos.	26 op. cases, 2+ aver. 2+ mos. 22 unop. cases, 3+ aver. 3+ mos.
Average period from initial symptom to death	6+ mos.	6 mos.	9 mos.	14 mos.	5½ mos.	9½ mos.	7+ mos.	7 mos.	5 mos.	3 mos.	10 mos.	6½ mos.	7+ mos.
Average period from initial focus to death	52 mos.	Uncertain	11 mos.	28 mos.	38 mos.	Uncertain	11+ mos.	59 mos.	107 mos.	11 mos.	12 mos.	63½ mos.	29 mos.
Single	7	3(?)	2	1(?)	?	3(?)	16	1	2			3	19
No. of metastases	6	3	?	?	1	2	12	2		1		3	15
Multiple	15		2	3	1	1	22	5	3			8	30
Diagnosis of malignancy made? Yes		6	2	1	1	4	14	2	1	1	1	5	19
Diagnosis of malignancy made? No													10

Carcinomata													
Primary malignant focus	Breast	Lung	Mouth and sinuses	Generative organs	Liver and intestines	Primary focus unknown	Total	Skin and retina	Hyper-nephroma	Generative organs	Myeloma	Total	Total all cases
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Unverified	9	0	2	3	1	1	16	4	2	0	1	7	23
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Headache	9	2	3	3	2	3	22	5	1	1	1	8	30
Vomiting	5	1			1		7	3	1			4	11
Loss of vision	4		1	1		1	7	2	1			3	10
Sensory	4			1		3	8		1			1	9
Motor	5	4	1	2	1		13	3	2			5	18
Average period from initial symptoms to admission to hospital	15 cases, 67 mos. aver. 4½ mos.	6 cases, 21 mos. aver. 3½ mos.	4 cases, 32 mos. aver. 8 mos.	4 cases, 31 mos. aver. 12 mos.	2 cases, 6 mos. aver. 3 mos.	5 cases, 31 mos. aver. 6 mos.	36 cases, 16 mos. aver. 5½ mos.	7 cases, 25 mos. aver. 3½ mos.	4 cases, 16 mos. aver. 4 mos.	1 case, 3 mos.	1 case, 10 mos.	13 cases, 54 mos. aver. 3½ mos.	49 cases, 54 mos. aver. 5½ mos.
Osteoplastic flap	3	5	1	1	1	3	14	3	1			4	18
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Improved	2	3		1			6	2	2			4	10
Not improved	3	2	2	1	1	4	13	4				4	17
Average period from operation or admission to hospital to death	5 op. cases, 2 op. cases, 2+ aver. 3 mos. 10 mos. 2 unop. cases, 4+ mos. 4+ mos.	5 op. cases, 3 op. cases, 10 mos. 1 unop. case, 3 mos. 3 mos.	2 op. cases, 1 op. case, 1½ mos. 3 op. cases, 1½ mos. 1½ mos.	2 op. cases, 1 op. case, 1½ mos. 3 op. cases, 1½ mos. 4½ mos.	1 op. case, 5 mos. 1 unop. case, 1 mos. 1 mos.	4 op. cases, 1 op. case, 1½ mos. 1 op. case, 2 mos. 1 op. case, 3 mos.	19 op. cases, 3+ aver. 3+ mos. 17 op. cases, 3+ aver. 3+ mos. 3- mos. 17 mos. 3- mos. 3- mos.	6 cases op. aver. 3- mos. 1 unop. case, 17 mos. 7 cases, 3- mos. 17 mos. 3- mos. 17 mos.	1 op. and rec. 1 op. case, 1 unop. case, 2 unop. cases, 4 mos. 4 mos.	1 op. and rec. 1 op. case, 1 unop. case, 2 unop. cases, 4 mos. 4 mos.	1 mo.	7 op. cases, 2+ aver. 2+ mos. 5 unop. cases, 3+ aver. 3+ mos.	26 op. cases, 2+ aver. 2+ mos. 22 unop. cases, 3+ aver. 3+ mos.
Average period from initial symptom to death	6+ mos.	6 mos.	9 mos.	14 mos.	5½ mos.	9½ mos.	7+ mos.	7 mos.	5 mos.	3 mos.	10 mos.	6½ mos.	7+ mos.
Average period from initial focus to death	52 mos.	Uncertain	11 mos.	28 mos.	38 mos.	Uncertain	11+ mos.	59 mos.	107 mos.	11 mos.	12 mos.	63½ mos.	29 mos.
Single	7	3(?)	2	1(?)	?	3(?)	16	1	2			3	19
No. of metastases	6	3	?	?	1	2	12	2		1		3	15
Multiple	15		2	3	1	1	22	5	3			8	30
Diagnosis of malignancy made? Yes		6	2	1	1	4	14	2	1	1	1	5	19
Diagnosis of malignancy made? No													10

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frequently as sarcoma and that in almost one-half of the carcinomas the primary focus was in the breast. In the sarcoma group the melanotic type and hypernephromata predominate. Considering examples of verified carcinoma (Table II), the tumor is recorded as single in ten instances, five in the left hemisphere, two in the right, and three in the cerebellum. However, in only three of these was an autopsy performed, the lesions being verified at operation. When compared with the 10 cases in which multiple tumors were found, all verified at autopsy, it seems most probable that had a more thorough examination been possible, many of those cases recorded as single would have been found to be multiple. Three of the sarcoma metastases were multiple, three single. Of the latter but one was verified at autopsy, two tumors being removed at operation. The three instances of multiple metastatic sarcomatous lesions were confirmed at autopsy. The evidence seems definite that in the great majority of instances, unless the tumor spreads by direct extension as may happen following a malignancy in the

TABLE II

Number and distribution of metastases	
A. Carcinoma—20 verified cases	B. Sarcoma—6 verified cases
10 cases multiple tumors—10 autopsies.	3 cases multiple tumors—3 autopsies
10 cases single tumor—3 autopsies	3 cases single tumor—no autopsies
5 left cerebral hemisphere	2 left cerebral hemisphere
2 right cerebral hemisphere	1 right cerebral hemisphere
3 cerebellum	

accessory sinuses, secondary malignant metastases to the brain are multiple.

Aside from a careful and thorough history and physical examination to determine whether they have or have not had any lesion suggesting a malignant focus, is there any striking feature in the clinical picture of these patients that might lead to a suspicion of its presence? Unfortunately the symptoms seem to be those which accompany any other intracranial growth causing increased intracranial pressure. Headache predominates as an early complaint, with vomiting and loss of vision less frequently noted. Motor and sensory changes depend largely on the position of the metastasis in the brain. It is curious how much more common motor symptoms are than sensory. There is one clinical fact that has been recorded by other observers (McCarthy,²⁸ Heyde and Curschman,²⁹ Löhe,³⁰ Barrett,³¹ Binswanger,³² Crouzon, Behague and Bertrand,³³ Lewis,³⁴ and Toulouse, Marchand and Pezé³⁵) and which appears sufficiently often in this series to be significant, namely, the sudden development of a psychosis. In thirteen patients dispositional changes and dulled mentality were observed. Ten of these thirteen cases were women. Twelve occurred following a carcinomatous implantation. Whether as suggested by Hassin²² the cause of the mental clouding is a general toxic encephalitis set up in the brain as a reaction to the malignant foci is not clear. But it is evident that if a woman of middle age develops a sudden psychosis with asthenia and signs of intracranial pressure, a primary focus of malignancy from which cerebral metastases may have occurred should be most

carefully sought. And the two most reliable methods for determining this diagnosis are a painstaking detailed history and a thorough physical examination.

It is satisfactory to record that in 31 of these 49 cases the true condition of affairs was surmised. In 22 out of the 23 unverified and in 9 among 26 verified cases a diagnosis of metastatic tumor was made. In 10 of this last series the finding of a malignant neoplasm was unexpected, it being supposed that a primary brain tumor was present. In all of the 15 instances of mammary carcinoma, in 3 of 5 cases of melanotic sarcoma and 2 in 4 of hypernephroma the proper diagnosis was made. In none of the 6 subjects harboring metastases subsequent to a primary pulmonary malignant focus was a proper conception of the pathology obtained prior to operation or necropsy.

That neither radical nor palliative surgery is of any permanent avail under these conditions is certain. The average length of life from time of

TABLE III

Operative results	
Operated cases—25 (2 cases still alive)	
Osteoplastic flap—16 cases lived 50 months, average 34 months.	
Decompression—9 cases lived 25 months, average 3- months.	
Non-operated cases—22	
Verified—4 lived 3- months.	
Unverified—18 lived 3 months.	

admission to this hospital to death in both verified and unverified cases, whether operated or non-operated, whether radical extirpation or palliative decompression was performed, was less than four months (Table III). It will be noted that these figures are based on 47 cases. One case in which the tumor extirpated was believed to be a metastatic hypernephroma returned with a recurrence. Following a second successful removal the pathological diagnosis was changed to chordoma. He is alive and well 30 months after the second operation. Aside from a temporary hæmaturia no signs of a renal growth were present, either before or after his stay in the hospital and the actual diagnosis remains in doubt. One other patient who has been lost sight of had a cerebral tumor enucleated in April, 1925, which resembled a metastatic carcinoma of pulmonary origin.

The results published by Tooth,³⁶ giving the survival period following operation for malignant metastases to the brain, confirm our opinion as to the ultimate hopelessness of surgery in dealing with these conditions. Following operation, 13 patients with metastatic sarcomatous lesions in his series lived two and one-half months; 8 with carcinomatous tumors lived an average of one and one-half months. Except for these statistics of Tooth, the literature contains few references to the survival period following cranial operations for malignant nodules. Lower and Watkins³⁷ report a case following carcinoma of the bladder which survived the extirpation of a single large evident that if intracranial metastases have occurred, the cancer cells evident that if intracranial metastases have occurred that the cancer cells

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are free in the blood stream, the bodily resistance to the neoplasm is broken down and that other organs beside the brain must be involved. The most that the surgeon is justified in attempting is a decompression to relieve pressure headaches. In this way the last days of the sufferer may be made more comfortable. Our conclusions are these:

CONCLUSIONS

1. About 4 per cent. of all brain tumors are malignant in origin.
2. Carcinoma is found more frequently than sarcoma, but a higher percentage of sarcomatous tumors metastasize to the brain.
3. Malignant metastases to the brain are in the great majority of cases multiple.
4. The commonest primary foci for carcinoma metastases are the breast and lungs; for sarcoma the skin and kidneys.
5. A suddenly developing psychosis when a history of a primary malignant focus is present is extremely suggestive of metastases to the brain.
6. Surgery, whether radical or palliative, is of no ultimate benefit to these patients insofar as prolongation of life is concerned. But surgical intervention for the relief of intracranial pressure is frequently indicated and may go far toward relieving suffering in the last few months of life.

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EXOPHTHALMOS: THE MECHANISM OF ITS PRODUCTION IN EXOPHTHALMIC GOITRE

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THE exact cause of exophthalmos in exophthalmic goitre is not known. The purpose of this paper is to call attention to an interesting phenomenon of the eyes observed in a case of exophthalmic goitre and to discuss the possible relationship of this phenomenon to the production of exophthalmos. A number of theories have been advanced to explain the occurrence of exophthalmos in exophthalmic goitre. The anterior displacement of the eyeball has been ascribed to an increase in the retrobulbar tissues, to a weakening of the muscles which retain the bulb in the orbit, and to the increased tonicity of muscles which draw the eyeball anteriorly. Jeandrassick and Mendel described an abnormal deposit of



FIG. 1.—Photograph showing the appearance of the eyes when viewed from the front.

retrobulbar fat. Muller thought there was an increase in the retrobulbar tissues due to a serous infiltration. Graefe, Sattler, and McKenzie believed that the increase in retrobulbar tissues was due to venous congestion. Atony of the muscles which retain the globe within the orbit has been thought to be the cause of exophthalmos by Traube, Recklinghausen, Bristowe, and Dalrymple. The fact that the protrusion of the eyeballs in exophthalmic goitre might be due to an increased muscle tonicity has been advocated by Landstrom. Landstrom demonstrated the existence of unstriated muscle fibres arising in the orbital septum and inserting on the equator of the globe so as to form a band about the eyeball.

The relationship existing between the increase in the size of the palpebral fissure and an existing exophthalmos has not been made clear. The statement has been made that the increased width of the palpebral fissure makes

exophthalmos more apparent than real, but it is generally accepted at the present time that there is an actual dislocation anteriorly of the globes in exophthalmic goitre. The fact that an increase in the width of the palpebral fissure might be a factor in the mechanism of the displacement of the eyeballs anteriorly in the exophthalmos of exophthalmic goitre has not been emphasized.

The observations to be described were made upon a white male patient, thirty-three years of age, who was admitted to the Vanderbilt Hospital on

January 5, 1926. This patient presented the cardinal signs and symptoms of exophthalmic goitre. The disease was of ten years' duration. The amount of exophthalmos which was present is illustrated in Fig. 1.

On examination of the patient it was noted that there was little or no exophthalmos when the eyelids were closed. Furthermore, if one of the eyes was carefully observed in profile, it was apparent that the eyeball receded into the orbit during the act of closure of the lids. It was also



FIG. 2.—Lateral view showing the position of the globe with eyelids open. Note the position of the cornea relative to the bridge of the nose. See Fig. 3.

interesting to note the fact that the greatest amount of recession of the eyeball into the orbit occurred before the lids were completely closed. If the patient was observed in profile with the eyelids closed to such a point as to produce approximately the normal width of the palpebral fissure, the recession of the eyeball into the orbit was sufficiently great as to leave little or no evidence of exophthalmos.

In order to study this phenomenon more accurately a kinetographic film was prepared of a profile view of one of the patient's eyes during the acts of opening and closing the lids. The study of this film revealed the striking amount of anterior posterior movement of the eyeball accompanying opening and closing of the lids. It also made it clear that the most of the movement of the globe occurred during the excursions of the eyelids between the points which marked the normal width of the palpebral fissure and its extreme width. The displacement of the globe anteriorly which accompanied the opening of the eyelids was particularly striking and suggestive of the important function of the lids in the retention of the eyeball in the orbit. As the

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palpebral fissure was enlarged by the separation of the eyelids there was very little anterior motion of the globe until the palpebral fissure enlarged beyond its normal width, after which the eyeball moved forward rapidly. The eyeball thus appeared to be extruded through the enlarged palpebral aperture. The relationship existing between the position of the eyeball in the orbit and the width of the palpebral fissure is illustrated in Figs. 2 and 3. These photographs were made without movement of the patient's head or the camera.

All of the theories which have been heretofore advanced to explain exophthalmos have

assumed that the dislocation of the eyeballs anteriorly is due to some force acting directly on the globe and that widening of the palpebral fissure is secondary to the exophthalmos. The study of the relationship of the size of the palpebral fissure to the position of the eyeball in the orbit in the instance described in this paper is suggestive of the fact that the position of the eyeball was largely dependent on the restraining force of the lids. The palpebral fissure can be compared with an incision. All tissues in the



FIG. 3.—Lateral view showing the eyelids closed. Note the position of the anterior surface of the upper eyelids relative to the bridge of the nose. The camera and the subject are in the same relative position as in Fig. 2. The amount of recession of the globe is apparent.

body exist in a state of constant tension. If the skin is incised, the wound gapes and the underlying tissues protrude. If the capsule of a gland is incised the glandular tissue bulges through the incision. Furthermore, if there is no co-existing pathological process which changes the nature of the tissue it will presumably subsequently resume its normal state of tension. With this idea in mind the relationship between the width of the palpebral fissure and the position of the eyeball in the orbit becomes apparent. The retrobulbar tissues must exist in a certain state of tension. The rigid walls of the orbit result in this expansile force being balanced by the eyeball which must in turn be partially restrained from movement anteriorly by the eyelids. If the palpebral fissure is enlarged, the restraining power of the lids is of necessity reduced in geometrical ratio because of the spherical shape of the eyeball. If these facts are placed in relation with the enlarged palpebral fissure and the infrequent closure of the lids which occurs in exophthalmic goitre, their importance in explaining exophthalmos becomes obvious.

Furthermore, it is obvious that this explanation of exophthalmos would of necessity assume an increase in retrobulbar tissue to occupy the space and maintain the tissue tension resulting from anterior movement of the eyeball. With this explanation increase in retrobulbar tissue is due to the anterior dislocation of the eyeball rather than the cause of it.

Müller described unstriped muscle in the upper lid between the levator palpebral superioris and the tarsal cartilage, and in the lower lid between the conjunctival fornix and the tarsal cartilage. It is possible that the contraction of these muscle bands, which are supplied by the sympathetic nerves, may produce widening of the palpebral fissure. It has been shown that changes occur in the cervical sympathetic ganglia in exophthalmic goitre.

It was thought that the exophthalmos might be benefited by diminishing the size of the palpebral aperture and maintaining the reduced size by some appliance. This was accomplished by the application of a colloidin dressing to upper lids with the eyes closed. With the upper lids thus stiffened, the patient was unable to open his eyes widely. The result obtained by the use of this simple procedure was such that its further trial is indicated.

If further observations prove that diminution of the restraining force of the lids is an important factor in the production of exophthalmos, a rational basis for therapeutic measures will have been established.

Conclusion.—Diminution of the effective restraining action of the eyelids is an important factor in the mechanism of the production of exophthalmos.

THE PATHOGENESIS OF THE END RESULTS OF THE LESIONS OF ACUTE OSTEOMYELITIS

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IN A general way most surgeons have the notion that acute osteomyelitis results in an irregular destruction of bone tissue. It is of great clinical importance that vague notions of this kind be crystallized into accurate facts. Then a knowledge of the end results of acute osteomyelitis will lead to a better understanding of the problem and to criteria which, based on correct anatomical and pathological observations, will enable a rational method of treatment of acute osteomyelitis to be formulated. To follow the line of reasoning still further would bring us back again to the possibility of improving the end results of acute osteomyelitis as far as form, function and consequent disability are concerned.

As far as the end results of osteomyelitis are concerned, a distinction must be made in a very specific way in cases of acute osteomyelitis between those with bacteraemia or general blood infection and those in which the blood cultivations are sterile. In the presence of a bacteraemia or general blood infection the end results of an acute osteomyelitis are entirely dependent upon the question of the bacteraemia. The end results of a bacteraemia are either an uncontrollable increase in the general blood infection and a consequent fatality; or a diminution and subsequent disappearance of the bacteraemia and a recovery. The end results of the bacteraemia or general blood infection lie apart from the purpose of this communication and will not be discussed beyond the mere mention of their existence. The purpose of this communication is the classification of the morphological results of acute osteomyelitis insofar as they involve changes in structural substance and in anatomical form and configuration and in the



FIG. 1.—A superficial form of osteomyelitis due to a thrombophlebitic lesion in the cortical vascular network. Note the small sequestrum and the absence of change in the rest of the shaft. This commonly gives rise to a subperiosteal abscess.

correlation of these facts with the anatomical and pathological facts outlined in previous communications.

In a previous communication the mechanism of acute osteomyelitis was described. The essential parts of this mechanism include (1) a bacteriæmia or general blood infection; (2) a fixation point in the vascular network of a bone (thrombo-embolic phenomenon); (3) the development of a pathological process characterized by a thrombo-arteritis or thrombo-phlebitis; and (4) necrosis of bone cells and tissue. These four factors were found to be able to explain fully every type of pathology and of clinical fact that occurs with acute osteomyelitis.

In a second communication the röntgenographic appearances of acute osteomyelitis were correlated with the anatomical, pathological and clinical facts of this disease. The following classification could be established:

1. A group of cases of subperiosteal abscess which are based upon an acute osteomyelitis in the superficial cortex of a bone of slight grade and extent. Fig. 1 illustrates this group.

2. A group of cases of acute osteomyelitis in which the main stem of the nutrient artery forms the fixation point and becomes occluded by the thrombo-embolic process and in which as a consequence the entire diaphysis becomes involved in the pathological process; maximum lesions occur. This group is recognized röntgenographically by the sequestration of the entire diaphysis of the bone. Fig. 2 illustrates this group.

3. A group of cases of acute osteomyelitis in which one of the primary divisions of the nutrient artery is caught in the thrombus-embolus formation. These are recognized röntgenographically as well as during operation when the involvement of the shaft of the bone occurs through the entire thickness of the shaft at one end of the diaphysis approximately to one or the other side of the point of entrance of the trunk of the nutrient artery. Such cases are easily recognizable in the X-ray photographs. Fig. 3 illustrates this group.

4. A group of cases of acute osteomyelitis in which the thrombus-embolus formation occupies one of the secondary branches of the nutrient artery. These are recognized röntgenographically and during operation when the involvement of the diaphysis does not extend throughout the thickness of the shaft of the bone. These seemingly follow no rule in their development are of irregular size and shape, frequently correspond to a thin shell of the cortex of the bone, occupy only a relatively small segment of the circumfer-



FIG. 2.—A tracing from an X-ray photograph of an osteomyelitis of the radius. The black area represents the sequestered diaphysis. Such röntgenographic appearances indicate a fixation point for the thrombophlebitic lesion in the main stem of the nutrient artery. Note the general configuration of the involucrum (A.)

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ence of the bone and depend for their physical characteristics and röntgenographic appearances upon the position of the secondary branch, its importance in the intraosseous vascular network, and upon the possibilities of collateral circulation. Fig. 4 illustrates this group.

5. A group of cases of acute osteomyelitis in which the thrombo-embolic lesion is situated in the terminal part of an end vessel of the intraosseous vascular network. The röntgenological appearances of the finished lesion is that of a cavity in the bone (Brodie abscess). Fig. 5 illustrates this group.

These five groupings are typical of sharply demarcated lesions differentiated from one another by the location of the fixation point in the intraosseous vascular tree and are built upon the consequences of the thrombo-embolic process which forms the basis of all cases of acute osteomyelitis. In clinical surgery it constantly happens that cases of acute osteomyelitis are treated primarily by drainage operations of various kinds in which the bone itself is not interfered with. In latter times this has apparently been the operation of choice in many quarters. Under such conditions the pathological process in the bone is allowed to progress and to attain its full development undisturbed. In such cases the differentiation of the cases into the given classification is very easily made from the röntgenographic appearances.

6. A group of cases of acute osteomyelitis in which more than one fixation point, either simultaneously or subsequently to one another, are formed within the confines of a single bone, at each of which a typical thrombophlebitic lesion develops independently of the

others. In the early stages of such a multiple pathological formation the lesions are distinct from one another and the röntgenographic appearances follow along the lines described in the previous five typical groupings. No further progression may occur. In many of the cases, however, the consequences of the initial thrombophlebitic lesion involve such an extensive part of the bone, that the several foci overlap one another immediately or coalesce



FIG. 3.—A tracing from the X-ray photograph of an osteomyelitis of the humerus. The black area represents the sequestrated portion of the diaphysis. Note that the lesion extends through the entire thickness of the shaft and that it extends from approximately the point of entry of the nutrient artery to the extremity of the shaft. The epiphysis which does not appear in the photograph was absorbed during the course of development of the lesion. The röntgenographic appearances are those of a thrombophlebitic lesion in one of the primary divisions of the nutrient artery. (A) is the sequestrum lying in a cavity; (B) in the centre of the involucrum. (C). Note the characteristics of the latter.



FIG. 4.—A tracing from an X-ray photograph of an osteomyelitis of the tibia. The shaded area represents the area involved in the process. Note that this area extends only partially through the thickness of the shaft and that it lies approximately between the point of entry of the nutrient artery and the end of the shaft. Compare with figure 3. The röntgenographic appearances are those of a thrombophlebitic lesion in a secondary branch of the nutrient artery.

subsequently at their peripheries so that a fusion occurs of more than one lesion; a large typical area of bone thus becomes involved. In such cases individual foci lose their identity in the röntgenographic pictures and their nature can only be surmised. Fig. 6 is a good example of this type of osteomyelitis.



FIG. 5.—An X-ray photograph of a comparatively early stage in the development of a bone abscess (Brodie abscess.) The röntgenographic evidence is that of a thrombophlebitic lesion in an end vessel of the intraosseous circulation. Note the absence of involucrum.

7. In a small percentage of the cases of acute osteomyelitis, the focus of infection not only involves the ramifications derived from the nutrient artery, but the periosteal network as well. Usually these are severe forms of infection and result in a total destruction of osteoblastic cells whether situated under the periosteum or in the endosteum. The end result is a loss of continuity in the given bone. Figs. 7 and 8 represent examples of this type of osteomyelitis.

In a fairly large proportion of the cases of acute osteomyelitis, this classification simultaneously represents a classification of the end results of this disease, as far as changes in substance, structure and form of the bone is concerned (when the contour of the bone is not mutilated in the operative manipulations which

accompany an osteotomy as hereinafter described) with the exception that following the casting off of the sequestra the subsequent healing of the wound would necessarily be accompanied by the formation, in greater or lesser degree of a protective involucrum. The character and general tendencies for the formation of the involucrum under these undisturbed conditions is best shown in all of the accompanying figures, the legends of which carry a full descrip-

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tion of the essential steps in the course of events. Such end results are fairly frequently seen in clinical surgery and can be demonstrated in the röntgenographic evidence and in operating room observations. (Figs. 9 to 14.)

Up to this point one might truly say that the previously described conditions represent the true end results of acute osteomyelitis *per se*. The appreciation of this fact is most important for a correct understanding of the pathological process and of its effects and for the formation of criteria upon which to formulate correct methods of surgical treatment and of operative manipulation. Whatever other changes and modifications of these underlying and essential anatomical and pathological facts and conditions are encountered in clinical, bedside and operating room observations are directly due (1) to the spreading characteristics of a thrombophlebitic lesion in osseous tissue; (2) to the mutilations of the bone which necessarily accompany any osteotomy; (3) to combinations of both of these complicating factors; and (4) to exacerbations of infection of endogenous or exogenous origin. A correct appreciation of the effects of these complicating factors is of such paramount value and importance as to cause their repetition here: A. Any increase in the extent of the intraosseous vascular clotting (*i.e.*, of the extent of the thrombophlebitic lesion) can occur in one of two ways: In the first of these, the clotting spreads along the vascular channels in the direction in which the blood current flows. Several possibilities follow:

a. A piece of the thrombus breaks off and lodges in a smaller vessel further along. This is one of the mechanisms for the formation of multiple lesions within the confines of a single bone. These usually take the form described (*a*) when a fixation point occurs in one of the secondary or subsidiary branches of the nutrient artery or (*b*) when the fixation point occurs in an end vessel. The accompanying clinical manifestations are those of an acute exacerbation of the process. The röntgenographic appearances under these conditions follow along those lines hereinbefore outlined in this communication either when the secondary lesions remain distinct from one another or when secondary

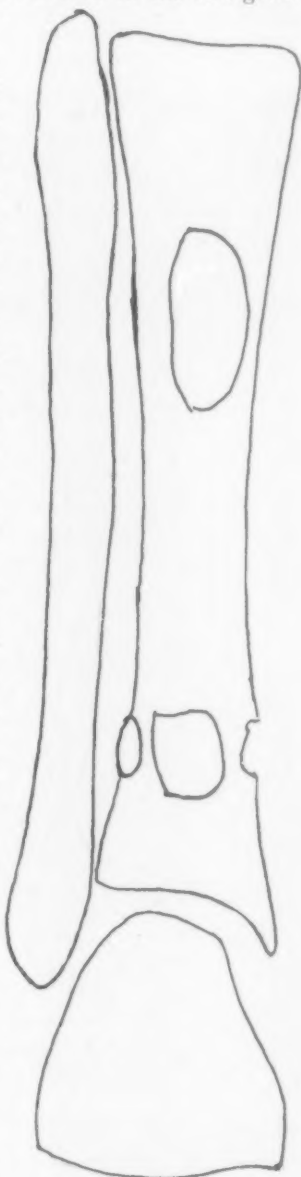


FIG. 6.—Tracing of an X-ray photograph of a tibia in which thrombophlebitic lesions formed simultaneously at four distinct fixation points. The X-ray evidences are very characteristic. (M. S. H. No. 203894.)

coalescence and fusion occurs. Such röntgenographic pictures are easily interpreted.

b. A progressive thrombosis, *i.e.*, a progressive increase of the thrombophlebitic lesion occurs along and in the direction of the vascular path; this practically always indicates a steady, slow progression of the infection along



FIG. 7.—An X-ray photograph of an osteomyelitis of the ulna. A similar lesion is present as in FIG. 2—that is a nutrient artery lesion. Note the general appearances of the involucrum. The absence of the involucrum at A indicates that the periosteal circulation is compromised at this point and that no osteogenesis is taking place. The röntgenographic appearances indicate that a solution of continuity of the bone is to be expected as an end result. This is shown in FIG. 8.



FIG. 8.—A later X-ray photograph of the same lesion as shown in FIG. 7. Note that after the sequestered shaft had been removed, two masses of involucrum remained at points corresponding to either end of the previously existing shaft. Note the absence of any involucrum in the centre resulting from compromise of the periosteal, as well as of the nutrient artery circulation in the central portion of the previously existing shaft.

the thrombus. A peculiar form of osteomyelitis results which is characterized by a slow, progressive involvement of the osseous tissue; clinically this is seen as a progressive molecular necrosis of the bone tissue in the wound surfaces. Operation—the usual form practiced is a curettage of the bone—is followed by no checking of the process. In this form of osteomyelitis it is found, clinically, that Dakin's solution has no sterilizing effect and the reason for this is obvious. This type of case is very difficult if not impossible to recognize from röntgenological evidence. This is the mechanism for the formation of that form of chronic osteomyelitis commonly designated chronic

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sclerosis of bone; a discussion of this form of osteomyelitis will be given in a later communication.

B. In the second place clotting may extend along the vascular channels in the direction the reverse to that in which the blood flows, that is, in a retrograde fashion. As soon as a branching of the blood-vessels is encountered the thrombotic process spreads along the branches (a) either in the direction in which the blood current flows, in which event the course of

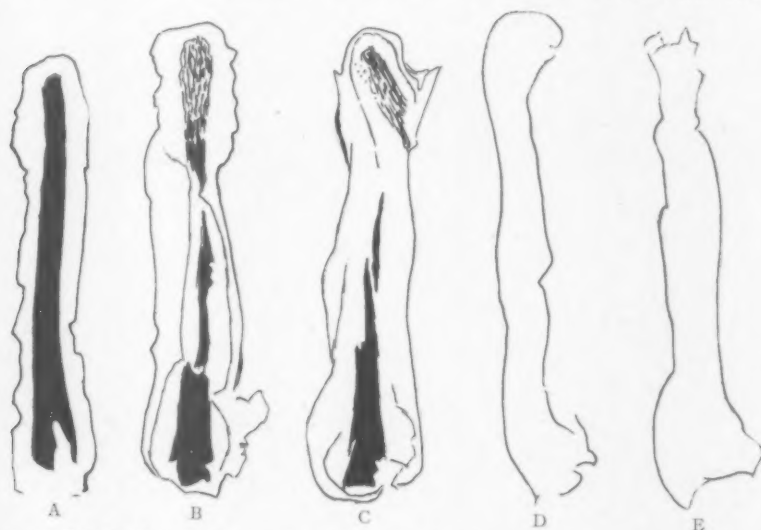


FIG. 9.—Tracings from the X-ray photographs of an osteomyelitis of the radius taken at intervals from one another. A, October, 1924; B, November, 1924; C, December, 1924; D and E (different views of the end result), February, 1925. A "nutrient artery" lesion. Note the general characteristics of the involucrum formation. The black or shaded areas represent the sequestrum in various stages of absorption.

events repeats those outlined in the previous paragraph; (b) or the extension continues in a retrograde fashion. A number of possibilities follow:

a'. If the size of the branching blood-vessels is very small, the character of the pathological process and of the corresponding clinical manifestations does not differ from that produced when the clotting spreads along the vessels peripherally as previously described.

b'. As soon as the retrograde thrombosis has reached the main stem of the nutrient artery any further spreading occurs either by a plugging of the main stem at the point of contact or by embolic processes further along the branching of the nutrient artery. In any event this reproduces the primary conditions associated with the inception of an acute osteomyelitis—*i.e.*, that is with the formation of fixation points and the development of thrombo-phlebitic lesions as outlined in previous communications and in the summary given at the beginning of this one. Röntgenographic evidence follows closely along the lines previously laid down and the various appearances visible in the X-ray pictures can be correlated according to the location of the fixation points in the intraosseous vascular tree. Single and multiple foci may develop in this way and, as previously described, the röntgenographic appear-

ences are those of individual lesions or of foci which have undergone coalescence and fusion. The clinical manifestations are those of an acute exacerbation or recrudescence of the pathological process or those of an entirely new development in the confines of the same bone. (Figs. 10 and 11.)

The phenomena accompanying the spread of the thrombophlebitis are

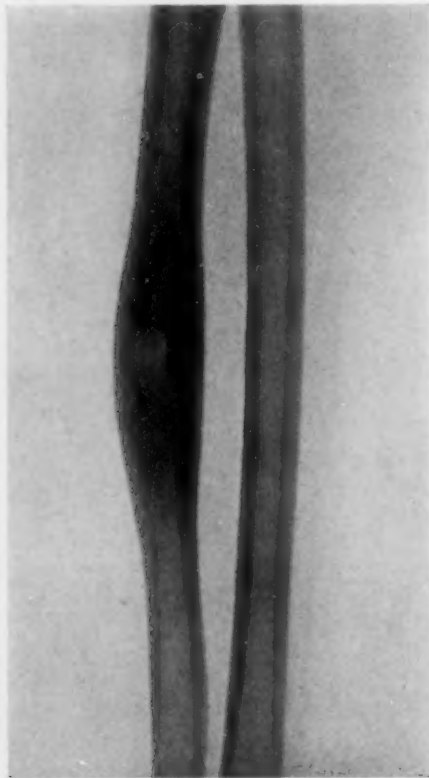


FIG. 10.—An X-ray photograph of an osteomyelitis of the ulna before operation. The roentgenographic characteristics are those of a thrombophlebitic lesion in a subsidiary branch of the nutrient artery, fixation point being in medulla of the bone. Small size of lesion indicates that actual vessel blocked is unimportant in the general vascular network of bone and that collateral circulation is abundant. Note that lesion does not extend across entire thickness of shaft and is fairly well localized. Entire focus was excised going into healthy tissue on all sides. Wound was packed wide open. On tenth day packing was removed and edges of wound were strapped together. Agglutination of wound surfaces followed.



FIG. 11.—The same case as FIG. 10 about three weeks after operation. A is the area removed at the first operation which by this time was practically healed. B is a new lesion formed by a retrograde spread of the thrombosis until it had compromised one of the primary branches of the nutrient artery. Note that the sequestrum extends through the entire shaft of the body to one side of the entrance of the nutrient artery. Compare with FIG. 3. Note the characteristics of the involucrum which is sufficient to bridge across the gap formed by the sequestration. The operative manipulations very likely had something to do with this spreading of the thrombosis.

particularly apt to occur after operation. They characterize a group of cases of osteomyelitis which directly after operation do not exhibit the expected retrogression and disappearance of the local inflammatory effects and a subsequent healing, but which instead, show an increase, large or small in the local focus. Exhibiting the same characteristics of the early unoperated cases of osteomyelitis, the roentgenological evidences of these phenomena are

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not immediately visible and are recognizable only later when the full effects of the increase in the thrombophlebitic process has become sufficiently established. Clinically these are recognizable by the continuation of the subjective and objective phenomena or by recrudescence or exacerbations of the process. Inasmuch as the essential mechanism of these post-operative phenomena are similar to those which occur spontaneously and before operation, similar results follow anatomically and röntgenographically; clinically these results are commonly seen. All of the characteristic phenomena which have been described in the previous part of this communication as regards the spreading of the original foci or formation of additional foci within the confines of the same bone, can and do occur post-operatively and are a direct consequence of the operation and can be recognized in the X-ray photographs. In this respect it is to be emphasized that the characteristics of the thrombophlebitis are aided and abetted by the operative manipulations, and that the latter play a rôle only in this way. It must be further emphasized that in no other way could the extraordinary and bizarre effects which are clinically seen to interfere with the control of the process and to disturb the smoothness of the healing of the wound be satisfactorily explained.

Figures 12, 13 and 14 illustrate these post-operative phenomena exceedingly well.

Discussion and Summary.—The problem of osteomyelitis is a complicated one inasmuch as an acute osteomyelitis must necessarily pass through all or many of the stages of a chronic osteomyelitis before its final end result can be determined. From the facts outlined previously in correlation with clinical knowledge it seems at the present moment that only in a minority of the cases of acute osteomyelitis does a definite end result seem possible of recognition in a definite and apparently permanent healing, which corresponds in its extent and in its characteristics with the formation of a fixation point and the uninterrupted and uncomplicated development of the thrombophlebitic process in one of its typical forms as outlined previously. In all the rest of the cases



FIG. 12.—Figures 12, 13 and 14 form a continuous story. Figure 12 is an X-ray photograph of a femur in which the extent of an osteotomy done for an osteomyelitis is shown at A.

of acute osteomyelitis the development of the thrombophlebitic process at any given fixation point is modified by the spreading of the thrombosis in the vascular network of the bone. A multitude of modifications are thus caused to occur all of which have the general tendency towards magnification and distortion of the pathological picture and of its röntgenographic appearances.

It is beyond dispute that in some cases of osteomyelitis a definite end result cannot be said ever to exist or to come to pass inasmuch as the modification of the pathological lesion is a continuous and progressive one. A stage of quiescence is never reached from which retrogression can take place and



FIG. 13.—Almost immediately following the osteotomy there was extreme pain in the hip which continued unabated for a long time. Figure 13 shows the condition which developed as a result of the spreading of the thrombophlebitic lesion. A shows the early stage of the development of a sequestrum which involved the entire neck of the bone. B is a later, fully developed stage of the sequestration in which a separation of the bony tissue has occurred just beneath the head. The area of the osteotomy is shown as in the photograph. An arthritis was, of course, present. Note the complete absence of involucrum.

healing follow. Instead of this, the magnification of the lesion continues slowly—or, sometimes, more quickly. These are those chronic cases of osteomyelitis with persistent, uncontrollable discharging fistulae which seem to defy our best efforts at treatment. In such cases there is no end result; our knowledge permits us at present and for the time being to classify these cases into a group which display the "tendency" of the thrombophlebitic process.

In a very large proportion of the cases of osteomyelitis this tendency is also shown in another way; the "end results" consist of the frequent recurrences which contradict the apparent "healings." In these cases stages or periods of quiescence do occur and the process remains in that condition for a variable length of time; retrogression does not follow, however, and any "healing" which occurs is a superficial matter which needs little or no stimulus to be destroyed, even after comparatively long intervals.

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Operation of whatever nature and performed by however expert hands, by its very technical manipulations is an important and prolific aid—however unintentional that may be—to the spreading propensities of the thrombophlebitic lesion. Old thromboses are frequently caused to spread; new thromboses are commonly caused to appear. Any osteotomy performed for an



FIG. 14.—Figure 14 is the terminal (?) stage of the process. A good deal of healing has taken place and the head has become united with the shaft. It appears as if the sequestrum had been permeated by healthy bone tissue. However at this stage about one year after operation the wound had not healed and much bare bone was felt in the bottom of the wound. Another operation will be necessary before healing can follow. This is one of the best examples of the damage which can unintentionally be done during an osteotomy over which one has no control.



FIG. 15.—The end result of an osteomyelitis of the lower end of the femur and the upper end of the tibia. Most of the mutilation did not result from the osteomyelitis but is the result of the various osteotomies which were done. Note the absence of involucrum formation. The entire lower end of the femur and upper end of the tibia were finally involved and infection of the joint followed. The final operation followed the type described by Mayo. At the present writing there is complete ankylosis between the femur and the tibia. A sinus is still present.

osteomyelitis necessarily destroys much healthy bone. (Fig. 15.) The trauma of the operative manipulation produces ideal conditions for a recrudescence of the infection—or a new infection is introduced. In all of these ways operation introduces artificial factors which magnify the lesion as defined by the initial fixation point and by the normal undisturbed development of the thrombophlebitis which results therefrom, and produces artificial distortions and changes of the true end results of the osteomyelitis. However much one may dislike it, it is necessary to appreciate the extent to which

in appropriate instances, operation can and frequently does do more harm than good. And in any case of acute osteomyelitis in which operation—an osteotomy—has been done, the end result of the total pathological process includes (1) the end result of the original bacteriemia; (2) the end results of the osteomyelitis *per se*—i.e., the end result of the thrombophlebitis at the given fixation point plus whatever spontaneous increase occurs by virtue of the thrombotic process; (3) the added destruction produced by the osteotomy—i.e., the volume of bone removed mechanically plus the added bone destroyed by operatively increased thrombosis or by infection or both (Fig. 15); and (4) the addition of new bone tissue—involucrum—produced during the healing of the focus of infection and the cicatrization of the wound. Much of the latter two factors is due to things which we unintentionally do during the performance of the osteotomy or unwittingly allow to happen during the healing of the wound, and is independent of the original bacterial infection (thrombophlebitis) of the vascular system of the bone.

Other factors enter into the problem when joint complications occur and when epiphyseal lines become part of the focus of infection, especially in younger individuals. Absorption phenomena and disturbances of growth then take place which are important factors in determining the end results of the focus of infection. The discussion of these problems is reserved for another communication.

I am indebted to Drs. A. V. Moschowitz, Leopold Jaches and Edwin Beer for permission to make use of the clinical and röntgenographic records of their departments. Some of the records are those of my own private patients.

NEW PRINCIPLES IN THE SURGICAL TREATMENT OF POSTERIOR CERVICAL CARBUNCLES

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THE present frequency of posterior cervical carbuncles has not resulted in the adoption of any uniform method of treatment. Among the last 30,000 surgical patients admitted to the wards of Bellevue Hospital, there were 160 with carbuncles of the back of the neck—one in every 188 bed patients. The wide diversity of methods by which these cases were managed proves the general acceptance of none.

Any plan of local therapy for cervical carbuncles must take consideration of: 1. The mortality rate. 2. The morbidity period. 3. The resulting scar, and, 4. The total time to complete recovery.

Operative Treatment.

—For practical purposes, local treatment may be divided into operative and non-operative methods. Surgery has persistently claimed for incision and excision



FIG. 1.—Method of taking measurement for moulded plaster-of-Paris splint, using a strip of gauze running from shoulder-tip to shoulder-tip and passing over cranial vertex.

procedures a minimum mortality and morbidity rate. The advantages of immediate excision have been summarized by Vance¹ as follows:

- A. Absorption immediately stops and the real danger to life is removed.
- B. The temperature goes to normal within twenty-four hours, like the crisis of a pneumonia.
- C. Pain is almost completely relieved, and sleep made possible.
- D. The appetite comes back at once, and with the cessation of absorption constitutional improvement begins without delay.

Yet the granulation and dermatization of an excision wound may require

many weeks of post-operative care. The operation also results in an extensive scar. To the operator, the degree of cervical deformity and the period of after-treatment are matters of small moment, while the removal of the infected and necrotic tissue is viewed as an emergency procedure. The patient, however, does not agree that the cosmetic effect is to be taken so lightly. Nor is the patient alone in recognizing certain disadvantages in present surgical measures. Each of the remaining forms of therapy is based upon medical authority. Not infrequently the surgeon will change his fixed rule of excision when treating a nurse, colleague or friend, and will attempt treatment through some other method, which he has hitherto considered



FIG. 2.—Showing plaster-of-Paris splint applied to one side of head and neck.

totally inadequate. The legitimacy of the patients' dread of radical treatment is strongly supported by such instances.

Non-operative Treatment.—The advantages claimed for non-operative methods of treatment are (a) that they eliminate the ordeal of an operation, and (b) that in certain cases they give a smaller external scar, and (c) result in a shorter period of treatment. These considerations are of no small moment to the patient. The means of accomplishing these ends are indeed varied. It is difficult to imagine any type of treatment which has not been advocated by some author. Physiological methods include active² and passive hyperæmia³ and vaccine therapy⁴; physical agents have been utilized, in the forms of heat,⁵ freezing,⁶ electrical⁷ and X-ray therapy,^{8, 9, 10} while, prominent among the many chemicals employed are carbolic acid,¹¹ magnesium sulphate,¹² collodion,¹³ zinc,¹⁴ ichthyol,¹⁵ etc., which may be used as pastes, liquids, or powders, either for external application, or for injection.

The disadvantage of these non-surgical measures is that they sacrifice aims of major to those of minor importance. The infected tissue is not decompressed at the acute state. The dangers of local or metastatic exten-

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sion are not immediately removed. To avoid the ordeal of an operation becomes a prime consideration. The attempt for a good cosmetic result is made paramount.

Lack of an Ideal Method of Treatment.—Of the four aims of therapy previously stated, some are met by one method of treatment, and others by another. But apparently no present method meets them all. An "ideal" treatment must have the lowest death rate, the fewest complications, and the shortest period of systemic involvement. These are objectives which have already been met by radical excision. Yet an ideal treatment must also shorten the period of disability and result in the smallest possible cervical



FIG. 3.—Plaster-of-Paris head dressing held in place by bandages. A recurrent head bandage and figures-of-eight to each shoulder and opposite axilla, are employed.

deformity. These latter desiderata are *not* satisfactorily met by present surgical methods.

New Principles in Surgical Treatment.—All of the aims of therapy may be more successfully accomplished by the application of two additional principles to present surgical procedures, namely, those of (a) rest through immobilization, and (b) plastic operation.

Immobilization.—Rest is a fundamental of surgical treatment. To secure adequate physiological and mechanical rest is the chief aim of a wide variety of surgical procedures. Strapping the chest is the major form of treatment for traumatic pleurisy; dilating the sphincter for fissure in ano. Immobilization is a basic principle in the management of fractures, sprains and contusions. In the gastro-intestinal tract, functional inactivity is produced through short-circuit operations or the formation of stomas between adjacent organs or to the skin. Splinting is essential to the prompt repair of sterile wounds; to the growth of dermal grafts, etc. The value of rest is

thoroughly appreciated in the treatment of acute infections. Immediate fixation of an infected hand has become a rule. Free use of the arm is contraindicated in the management of an extensive axillary infection; walking is similarly prohibited in the face of severe inflammations of the inguinal region, and speech restricted in the presence of cellulitis of the lip or throat.

The lack of immobilization in the present routines of treatment for infec-



FIG. 4.—Showing plaster-of-Paris head dressing held in place by means of adhesive strips.

tions of the neck is in striking contrast to this widespread application of the principle elsewhere in the body. Yet in no region is the indication for rest so clear, the area more motile, the fascial planes more complicated, nor the dangers from the spread of infection more real. Posterior cervical carbuncles lie directly upon the muscle bed of the trapezii. Local extension, blood stream invasion, and the formation of metastatic foci are alike invited by each movement of the trapezii, sterno-mastoids, scaleni, or other cervical muscles. At present the only splinting is that

rigidity provided by nature due to the pain from such movements. Probably no portion of the body is less frequently immobilized in routine surgical practice.

The unusual danger in cervical infections has been ascribed to the anastomosis of certain veins in the neck with those of the meninges. Yet a critical view reveals that the fatal sequelæ from these carbuncles are not meningeal nor cerebral extensions, but septicæmia, bacteriaemia and pyæmia with the attendant complications of terminal pneumonia, exhaustion, etc. The danger from a posterior cervical carbuncle is the same as that from a serious infection localized elsewhere—and in the light of this fact it is a fair assumption that the higher mortality and slower healing are due to inferior methods of treatment in this particular region of the body. Were rest to be dispensed with in dealing with acute infective processes elsewhere, the dangers in cervical inflammations would not remain preëminent.

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Such considerations as to the value of immobilization to the neck are not alone theoretical. Reporting cases treated as early as 1850, Mr. John Hilton, in his surgical classic, "Rest and Pain,"¹⁸ deals at length with the curative effect of limiting motion in the neck, both for acute and chronic cervical infections, stating that "through providing adequate rest to the parts, many of these cases which seem to defy every kind of treatment may be successfully dealt with." Mr. Hilton has placed such insistence upon rest that one of his illustrative case reports may well be reproduced completely:

"We all know that it is not easy to manage successfully the treatment of a patient who has had a large carbuncle on the back of the neck near the scalp, which, by destroying the subcutaneous areolar tissue and fascial structures has left large portions of loose overlapping skin, blue, dark-colored and congested, showing a very feeble power, and, in addition to this, exposing the trapezii muscles to view.

"Some years ago I saw the wife of a physician whose condition accurately resembled that which I have just delineated. She had been previously attended by an eminent London surgeon. The case was not proceeding satisfactorily; there was no local evidence of repair; and the wound had remained stationary some time before my visit. On looking at the patient's neck, it appeared to me that there were two additional requisites in the treatment that might cure; one was to arrange some simple mechanism which would keep the trapezii muscles quiet; and the other was to support and maintain in perfect rest, the feeble flaps of skin. After laying the flaps of skin neatly upon the subjacent muscles a thick pad of cotton wool was placed over the flaps and surrounding tissues. A bandage was then applied around the head, and extended as a figure-of-eight crossing behind the neck and under the armpits, in order to fix the head, neck and shoulders, and control the trapezii. In twenty-four hours the healing had commenced and continued to a speedy termination.

"In another case where a sinus had existed in the neck for two years, a cure was obtained in three weeks through simple rest. I am almost afraid you may be induced to fancy I am using the language of exaggeration in this statement; but I assure you I really am not. In this instance the head was steadied by a crude pasteboard splint, formed roughly to fit the shoulders, back of the head and neck, laterally on each side, so as to include the head in a circle of pasteboard. This splint was made off-hand with wet, soft, thick pasteboard, covered by linen pressed upon the surface of the body, so as to become moulded to it, and then allowed, by the bandaging, to dry firmly in this position. This patient was quickly cured by simple rest."

The value of these teachings has been seriously interfered with by the crudity of the suggested fixation devices. The use of wet pasteboard boxes is ingenious, but is not readily adaptable to routine surgical dressings. In



FIG. 5.—Windows in plaster strip to expose ears. A modification of the cervical immobilization splint.

spite of the brilliant results in Mr. Hilton's cases and the soundness of his teaching, the fact remains that text-books on bandaging do not furnish simple, yet reliable methods for fixation of the neck. Immobilization is not at present stressed as an essential in the treatment of acute or chronic cervical infections.

Complete fixation of the neck may be obtained through the use of a simple plaster-of-Paris splint. The head dressing here proposed is made as follows: Measurement is taken with a piece of bandage from shoulder tip to shoulder tip, the line of measurement running over the cranial vertex. (Fig. 1.) A moulded plaster splint of this length and about three inches wide is constructed by overlapping turns of plaster bandages. One end of the splint is then placed over the acromial end of the right clavicle, the splint running from this point to the base of the neck, up the right side of the head with its centre at the vertex; then down the left side of the head, and across the left shoulder, ending at the acromial end of the left clavicle. (Fig. 2.) A thick pad of cotton is employed throughout the entire length of the plaster. The splint is then held in place by means of a recurrent bandage to the head and figures-of-eight to each shoulder and opposite axilla. (See Fig. 3.)

This dressing is subject to various modifications. When the splint is thoroughly dry, the figure-of-eight bandages may be dispensed with and two adhesive strips, each two inches wide, utilized to fix the lateral wings of the splint. (Fig. 4.) Windows may be cut in the plaster, when partially dry, to expose the two ears. (Fig. 5.)

A further modification consists of moulding an ovoid extension into the central portion of the plaster splint which, when applied, fits to top of the head as a cap, giving greater security and comfort. (Fig. 6.) A loop of gauze or ring may be incorporated into the centre of the splint to be later used in the



FIG. 6.—Showing ovoid extension moulded into centre of cervical splint. A modification insuring better coaptation to head.

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application of dry heat—a light bulb being suspended from this point as shown in Fig. 7, and all dressings dispensed with.

The possible objections to such a dressing might be anticipated by answering certain inevitable questions. Is the splint difficult to apply? How can the patient sleep in this device? Is it not heavy and uncomfortable? If this dressing presented technical difficulties in its application, and if it were heavy and uncomfortable, yet its usefulness would in no wise be diminished—for, who would discard the plaster jacket, hips spica, or even the circular cast to the thigh, or Velpeau bandage because they were difficult to apply or irksome to the patient? That the dressing does not interfere with sleep is shown by practical experience in the wards; the application of this straight piece of plaster is, indeed, simple; while it proves neither heavy nor bulky to the patient, who is glad to relax to the support of the plaster and cease the exhausting efforts at self-maintained rigidity.

The major function of this head dressing is to provide complete immobilization of the neck; yet it likewise has certain

additional advantages. 1. All pressure is relieved from the diseased area. The dressing to the carbuncle is no longer pulled firmly against the inflammatory tissue by hitches across the forehead, but aseptic pads are loosely applied by adhesive tape running to the sides of the splint. (Fig. 8.) 2. There is no tendency, as in other carbuncle dressings, for the bandage to "slip down," exposing the infected and infectious zone. (3.) The patient is under less muscular strain and the pain is diminished through the use of this artificial support. The remarkable speed with which granulation tissue forms and healing takes place under the use of cervical immobilization may be due, in part, to these factors as well as to the enforced inactivity of the underlying muscle bed.

B. Plastic Operation.—The advantages of a sliding flap operation are self-evident and the consideration of this principle may be brief.



FIG. 7.—Showing method of applying fixation and dry heat to back of neck.

As a result of every carbuncle there is a loss of tissue. The necrotic mass comes away in spite of any method of treatment employed. In the course of this disease are two stages—the time taken for the removal of the gangrenous core, and that taken for the healing of the inevitable wound. By means of excision the first stage is completed immediately; yet the second stage is uniformly tedious. In case treatment is non-surgical, the first stage consumes from five to fifteen days, after which healing begins. Irrespective of the method of treatment employed, after-care depends largely upon the size of the skin defect. The fundamental disadvantage of radical opera-

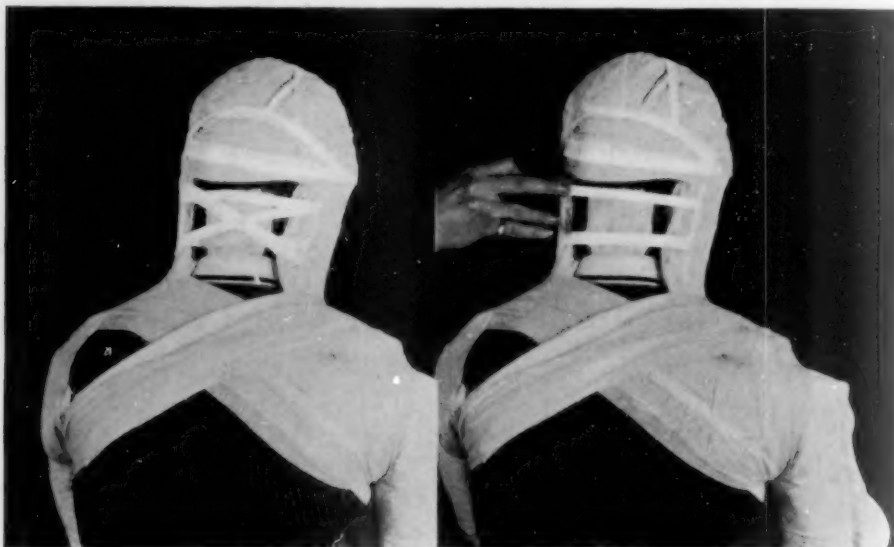


FIG. 8.—Showing free exposure of carbuncle site and loose application of dressings by means of the cervical immobilization splint.

tion—notwithstanding its thoroughness and added safety—is that it results in an extensive loss of skin.

In an attempt to minimize this loss, flap operations have been devised. It was found that to raise a cutaneous flap in no way interfered with the removal of subjacent slough. It was also found that exceedingly sluggish skin would frequently revive following the removal of this necrotic tissue. Edmunds¹⁷ has recently stressed the importance of skin flaps. The manner in which they minimize the denuded wound is shown in Fig. 9. Flap operations, then, have diminished the size of the denuded area, but have failed to close it.

The introduction of the plastic principle offers definite new benefits. A sliding flap frequently makes possible the complete closure of the carbuncle bed. It insures a smaller scar which in favorable cases consists of simple straight lines. The plastic method results in complete healing before dermatization of a granulating wound could well commence. By its use dead skin and that of doubtful viability is removed and each flap is left with a

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healthy margin. The construction of skin flaps relieves radical operation of its outstanding disadvantage. This procedure meets all of the aims of therapy for posterior cervical carbuncles: it insures the lowest mortality; the shortest morbidity; a minimum scar; and the briefest period of after-treatment.

More than one technic is available for plastic operations upon the neck. Certain principles of plastic surgery adaptable to any region of the body are well known. The fundamentals of the method are: that the flaps have a

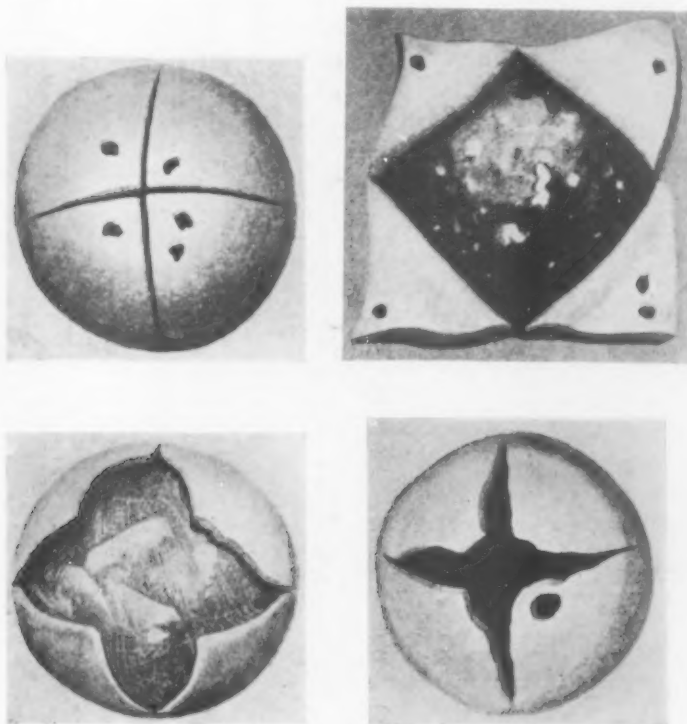


FIG. 9.—Usual crucial incision, showing central denuded area which must granulate and dermatize. (Cuts from Edmunds, *Lancet*, April, 1926.)

relatively narrow, or pedicle, base; that they be undercut to allow for subsequent displacement; that they be kept mobile, and not allowed to become fixed until a granulating base has appeared; that at this time they be approximated in a manner which will close the wound; that they be so held until fixed.

The method here advised consists of a double crucial incision as shown in the accompanying cut. (Fig. 10.) The central portion is entirely removed—both with its skin and areolar tissue. Flaps *a* and *b* are dissected well laterally and form the sliding units. The remaining flaps, *c*, *d*, *e*, and *f*, *g*, *h*, are reflected only so far as the individual case requires. There is no novelty in a double crucial flap incision. The point at which this method varies from those already in use is the introduction of the plastic principle. The con-

struction of sliding skin units makes possible the closure of the wound, obviates the tedious process of dermatization and provides a symmetrical replacement of skin, reducing the permanent scar. The distinction between this plastic procedure and the single crucial incision of carbuncles is even more obvious, for, with the single crucial incision, each flap consists of a quarter circle; its base is not adapted to changes of position; its margins are necrotic and infected, and a central denuded area is always present. Following the plastic operation a granulating bed appears by the fourth to the sixth

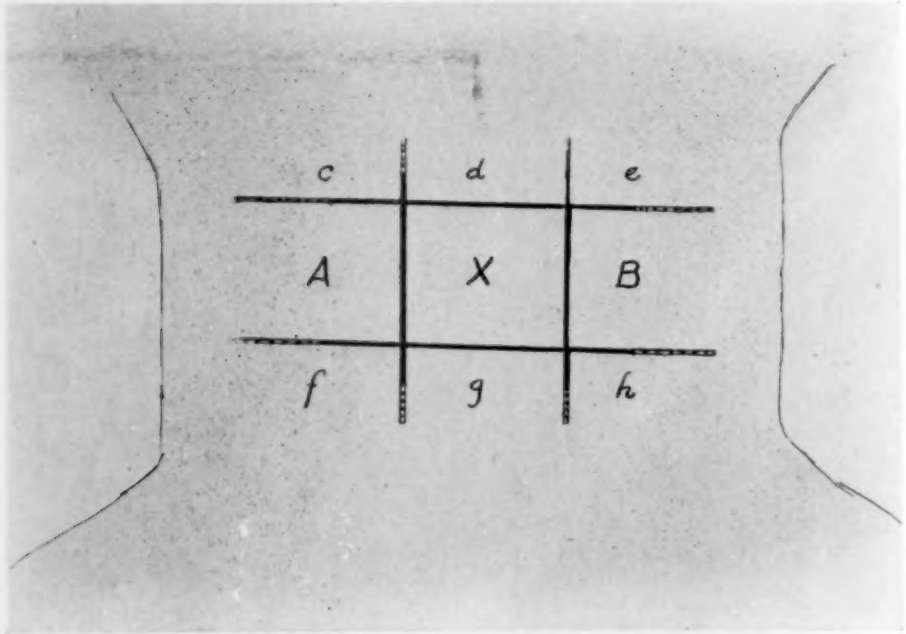


FIG. 10.—Plastic operation. Sliding flap excision of cervical carbuncle. X, Excised, A, and B, Undercut to form sliding skin flaps, to be brought to midline when granulation has progressed. c, d, e; f, g, h, Undercut as required in individual case.

day and the flaps are approximated at this time. (Fig. 11.) They are held in apposition by strips of adhesive and an additional three to four days is sufficient for the firm fixation of the displaced skin. In the average case in which it has been possible to completely close the excision wound with sliding flaps, all dressings may be dispensed with the seventh to the tenth day following operation.

While the principle is applicable to every cervical carbuncle at some time in its course, it cannot be successfully utilized in certain neglected cases encountered in hospital practice. Sliding flaps of sufficient mobility to compensate for the excised tissue cannot be prepared in untreated cases in which the carbuncle covers the entire dorsum of the neck; neither may they be obtained in late cases in which wide areas of skin have sloughed away. In such instances ideal treatment and results are not possible. Nevertheless, carbuncles with diameters of 8 to 10 cm. have been completely closed by

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this method, and in every case in which excision is made, the principles of cervical immobilization and of plastic operation tend to minimize the denuded area and to shorten the period of healing.

SUMMARY

A typical case of posterior cervical carbuncle, then, is treated as follows:

a. An immediate excision of the necrotic tissue is made, by means of a double crucial incision, so planned that two lateral sliding flaps are fashioned.

b. The flaps are elevated by means of vaseline gauze and the wound packed for 24 hours.

c. The neck is at once immobilized by means of a special plaster-of-Paris head-dressing, as herein described.

d. At end of 24 hours wound is exposed and treated by dry heat.

e. With the first formation of a granulation base, the wound is covered by means of the plastic skin flaps.

f. These flaps are maintained in position by adhesive strips until they have become firmly fixed.



FIG. 11.—Showing sliding flaps held in place by adhesive tapes. Fourth day after operation for extensive cervical carbuncle.

CONCLUSIONS

1. In the treatment of posterior cervical carbuncles, the addition of two new principles to the present surgical treatment more successfully accomplishes all aims of therapy.

2. These principles are *a*, to secure rest through immobilization, and *b*, to employ a plastic type of operation.

3. Immobilization is secured through the use of a plaster-of-Paris dressing which may be varied to meet special requirements of the individual case.

4. The plastic operation consists of a double crucial incision with the formation of two sliding lateral flaps, planned to completely cover the denuded area caused by the loss of necrotic tissue.

5. This operation minimizes the cervical deformity, and in favorable cases results in a scar consisting of straight lines.

6. Through utilizing these principles the tedious process of dermatization is obviated.

7. These procedures reduce the total time of treatment of posterior cervical carbuncles by 50 to 75 per cent. over present surgical or non-surgical methods.

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SYMMETRICAL LATERAL ABERRANT THYROIDS

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ABERRANT thyroids situated in the median line are not uncommon. Median thyroids represent remnants of the thyroglossal duct. Their most frequent location is at the base of the tongue.

Lateral aberrant accessory thyroids are much rarer. They represent remnants of the lateral "anlagen" of the thyroid gland.

Martin presented a case of lateral accessory thyroid before the New York Surgical Society in 1914. The rarity of this condition is best demonstrated by the fact that a case of similar nature was not presented before this Society during the last twelve years.

I wish to put on record a case of symmetrical lateral thyroids. If unilateral accessory thyroid seems to be of uncommon occurrence, bilateral aberrant thyroids seem to be extremely rare. At least in a casual perusal of the literature on this subject, I have not been able to find a case corresponding to the one presented herewith:

R. M., female, sixty-six, was admitted to the Surgical Service of Beth Israel Hospital, February 20, 1925. She gave the following history:

She had noticed two swellings at the angle of the jaw, one situated on the right side, the other situated on the left side, for at least thirty years. The swellings did not increase in size and never gave her any trouble. About ten days before her admission to the hospital, the right side of her neck began to swell. This swelling was most painful.

Upon her admission this patient presented a large, very tender and markedly œdematous swelling of the right side of her neck. This inflammatory mass was very large, nearly the size of a fist. The swelling extended to the midline and up to the angle of the jaw. However, it was not attached to the mandible. The mass extended below almost to the clavicle and posteriorly well beyond the outer border of the sternocleidomastoideus. At the lower part of the swelling one could feel a calcified plaque, the size of a quarter. There was marked fluctuation and marked tenderness on pressure.



FIG. 1.—Symmetrical lateral aberrant thyroids.

RICHARD LEWISOHN

On the left side of the neck there was a round firm swelling under the angle of the jaw, about the size of a plum. This mass was not tender. (Fig. 1.)

The thyroid gland was not enlarged.

Temperature, 101; pulse, 100.

Impression.—Infected cyst of the neck. Possible origin: (1) Thyroid (?); (2) branchiogenetic cyst (?); (3) lymphomata (?).

Operation.—February 23rd (Lewisohn): An incision was made at the lower angle of the mass and a large amount of pus was evacuated. A drainage tube was inserted.

Cultures of the pus showed a streptococcus. The acute infection subsided in a few days, and a mass, about the same size as that situated on the left side, was now palpable at the right angle of the jaw.

March 5th: A discharging sinus still persists on the right side.

March 7th, second operation: Skin and fascia incised over swelling. The tumor was easily dissected free from the underlying structures. Its removal did not present any technical difficulties. The tumor appeared solid and of rather firm consistency. Closure of the skin with silk; insertion of a rubber tube.

March 15th: Wound completely healed.

Microscopic examination (Doctor Gross)

showed the tissue to consist largely of colloid acini lined by a flat epithelium. Here and there acini were seen which were lined by cuboidal epithelium and showed papillary infoldings. The tissue showed extensive fibrosis and mottled areas of calcification. A few areas of recent

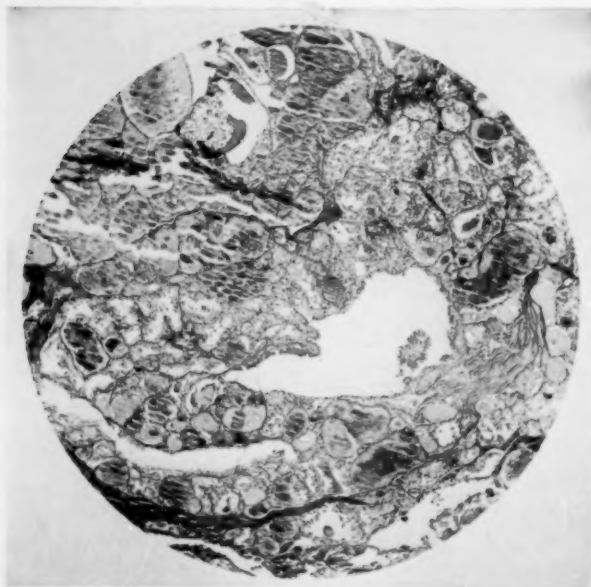


FIG. 2.—Aberrant thyroid adenoma.

hemorrhage, as well as older areas showing phagocytosis of broken down red blood cells were scattered here and there throughout the section. (Fig. 2.)

Diagnosis: Aberrant thyroid adenoma.

We were naturally very anxious to remove the tumor on the left side, which corresponded in location, shape and appearance to the mass removed by operation. However, the patient would not consent to a removal of this tumor, which had never given her any trouble.

The patient died October 27, 1925, from kidney disease. Her neck had never given her any trouble since the operation (statement of her daughter).

Accessory thyroids fall into two groups, true and false accessory thyroids. The true accessory thyroids have no connection with the thyroid gland, whereas the false accessory thyroids are connected with the thyroid by a strand of glandular or connective tissue. The case presented herewith represents undoubtedly the variety of true accessory thyroids.

Malignant degeneration of accessory thyroids is not uncommon. Cases of

SYMMETRICAL LATERAL ABERRANT THYROIDS

this nature have been published by Gerster, Pool, Venot, *et al.*, Schrager, Billings and others.

A pre-operative correct diagnosis is hardly ever made. These tumors were usually operated as lymphomata, branchiogenetic cysts, tumors of the carotid body, etc. The statement of some of the patients that the masses increased and decreased in size at different intervals might have led to a correct diagnosis.

It is important to ascertain in these cases the presence of a thyroid gland in its normal location. Extirpations of aberrant thyroids have led to serious complications in cases in which the thyroid gland failed to develop in its normal position. In view of the fact that a correct pre-operative diagnosis is very rarely made, the removal of a mass, representing an aberrant thyroid, may be followed by very serious results. It seems, therefore, of the utmost importance to consider the possibility—rare as it may be—of an aberrant thyroid, before removing so-called glandular tumors of the neck.

I am very sorry that I was not able to ascertain the exact nature of the swelling on the left side of the jaw by microscopical examination. However, the fact that the tumor on the right side consisted of thyroid tissue only and that the tumor on the left side coincided absolutely in shape, size and location with that on the right side leaves no doubt in my mind that this patient represented the extremely rare condition of symmetrical lateral true aberrant thyroids.

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TUBERCULOSIS OF THE MAMMARY GLAND

A REVIEW OF THE LITERATURE AND REPORT OF SIX ADDITIONAL CASES

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TUBERCULOSIS of the breast is a disease of infrequent occurrence in relation to the incidence of tuberculous infection in other parts of the body. It is found in only a small per cent. of surgical breast conditions; MacCarty and Durante quote Deaver as finding 0.83 per cent., Scott 1.4 per cent. and Bloodgood 0.6 per cent. of all their breast specimens tuberculous.

Anspach, in 1904, reviewed the literature up to that time and compiled 77 cases, 42 being primary and 35 secondary. Deaver, in 1914, considered the cases reported since 1904 and accepted 74 cases as proven tuberculosis, 45 of this series being primary and 29 secondary. Since 1914, the following series of cases have been reported: Miles, 6; Gatewood, 5; Durante and MacCarty, 10; Hamilton, 1; Levitt, 2; Elkin, 7; Cahill, 1. To these we add a report of 6 cases from the files of Barnes Hospital.

The significant features of Deaver's review are as follows: Absolute diagnosis depends on bacteriological and pathological study. Most "primary" tuberculosis of the breast is probably secondary to some clinically undemonstrable focus. In some cases "... We may ... consider the breast subject to primary tuberculosis as the result of infection through abrasion of the mammary skin or nipple, through the milk ducts, and rarely as a result of lymph- and blood-vascular infection."

"Secondary mammary tuberculosis arises by direct extension from a contiguous area of infection or by blood- or lymph-vascular metastasis from a distant focus."

The age limits of his collection were 14 and 73, with 60 per cent. of primary cases between the ages of 30 and 50. Of the secondary cases 41.9 per cent. were found to lie in the same age-period.

In the 45 primary cases, 51.1 per cent. were women who had borne children, and in the 29 secondary cases, 27.5 per cent. were parous. Anspach's figures, quoted by Deaver, correspond closely with the above. Heredity appears to be relatively unimportant, since there was a family history suggestive of tuberculosis in only 4 secondary and 3 primary cases. Of the 45 primary cases, 5 had apparently been influenced by trauma. A history of suppurative mastitis, 1 to 37 years previous to the tuberculous process, was given by 6 of the primary and by 2 of the secondary group. There was no very constant location in either group. The skin was unaffected in 27 of the primary cases, while 10 of the secondary cases had no skin involvement. Fourteen primary and 13 secondary cases had fistulas. The initial symptom was a painless lump in 68.8 per cent. of primary and 75 per cent. of the secondary cases.

Deaver recognized 5 varieties of the process: Acute miliary tuberculous mastitis, nodular tuberculous mastitis, sclerosing mastitis, mastitis tuberculosa obliterans, and atypical forms.

For chart of the cases we have collected since 1914 (see page 680).

TUBERCULOSIS OF THE MAMMARY GLAND

CASE I.—Mrs. S. McA., multipara. Age twenty-five, white. Factory worker. This patient entered Barnes Hospital, March 20, 1912, with the chief complaint of a lump in the left breast. Family history was negative as to tuberculosis. Her general health had always been fair—pertussis and tonsillitis in childhood, rheumatic fever at 12, measles at 23. She had had frequent colds.

She first noticed a soreness in the breast in the eighth month of her second pregnancy, with no swelling. The soreness continued in July; she noticed a lump in the breast just before her confinement July 24, 1911. At this time the breast was very red. During the engorgement of the breast following labor the pain was excruciating. The engorgement subsided and the pain was gone in about two weeks post-partum. A lump remained in the breast. There was no further trouble until one week before admission, seven months post-partum. At this time there were "darting" pains in the breast accompanying the formation and rupture of an abscess. Relief of pain followed the rupture. The discharged fluid was said to be about a tablespoonful of yellow serous fluid containing lumps. There was no discharge from the nipple.

Physical examination showed an inguinal hernia on the right, and no other abnormalities except the left breast, which was the same size as the other. Just above the nipple, involving the areola and adjacent skin, was a reddened area 1 x 1.5 cm. There was no discharge, the skin was puckered, the nipple retracted, with its base pulled upward. Superficial induration was made out under the red area, and beneath this was palpable a larger mass.

The condition was diagnosed as an early malignancy with abscess formation, and a radical excision was done. A cyst was found at operation; it ruptured during removal.

The healing was good, and good function of the arms was obtained.

Pathological Report.—Fluid from cyst: Sterile. Gross pathology: To one side of the nipple beneath the skin is an irregular cystic cavity containing a bloody granular material. The cyst wall also has a granular appearance. There are no papillary growths in the cyst. The breast tissue elsewhere is thicker and firmer than normal. The axillary lymph-glands are slightly enlarged and on section show several grayish translucent areas, sharply circumscribed about the size of a pinhead.

Microscopic: The cyst wall is fibrous, infiltrated with many lymphocytes and scattered giant cells. Extensive caseation is found in the area of the small tubercles. Elsewhere the fibrous tissue is abundant and is hyalinized in some places. Lymph-glands show scattered hyaline areas with giant cells.

Diagnosis: Tuberculosis of the breast and axillary lymph-glands.

CASE II.—Mrs. J. S., white, parous, housewife, age twenty-three. Admitted December 10, 1915, with chief complaint of "lump in left breast." Family history was negative. Her health had been generally good—measles, mumps and pertussis in childhood, and occasional attacks of tonsillitis. She gave birth to a child in February, 1914, and nursed it at breast for eight months. In June, 1914, the patient was confined to bed with pain under the lower ribs, worse on the right. The right side of the neck was swollen and stiff at the same time. Her physician thought the condition due to a "lung infection." The patient was in bed seven weeks and lost 23 pounds, but later regained weight and strength. For part of this time she nursed the child but weaned it in August because of her own condition; she had had no breast symptoms.

In March, 1915, she noticed slight pain in the left breast from carrying her baby against it. On examination she found a lump as big as her thumb medial to the left nipple. A month later it was twice as big; it was never painful except on pressure. Two months after the lump was found it was as large as an egg. Ointments were applied for a month with a reduction in size of the lump. At this stage it was very hard; it later became softer. Applications were continued two months and an ulcer appeared above the nipple, and discharged pus. With application of ointments to the ulcer, it partially healed.

TABLE I.
Summary of Cases from Literature.

No. of cases reported since 1914-32	Primary	Secondary	Sex	Age	Family hist. tuberculosis exposure	General health	Other tuberculosis processes	History of trauma	Cervical nodes	Axillary nodes	Sinus	Pain	Lactation	Affected breast	Pathological type of lesion	Treatment	X-ray	Results
Cahill 1925 1	+		♀	13	1	Good	0	+	1	1	+	+		Lt.	Single abscess. Nodular	Simple ampt.	1	Good
Elkin 1923 1	+		♀	36	1	Good	0	0	0	+	+		0	Rt.		Local ampt.		5 yrs. good
2	+		♀	21	1	Good	0	+	0	+	+		0	Lt.		Local ampt.		6 yrs. good
3	+		♀	26	1	Good	0	+	0	+	+		0	Rt.		Partial ampt.		2 yrs. good
4	+	+	♀	24	+	Fair	Rib	0	0	+	0		+	Lt.		Removed sinus and rib		3 yrs. good
5	+		♀	23	1	Good	0	0	0	+	+		+	Lt.		Radical ampt.		18 mos. good
6	+		♀	37	1	Good	0	0	0	0	+		+	Lt.		Partial ampt.		3 mos. good
7	+	+	♀	34	1	Fair	Lungs	0	0	0	+		+	Rt.		Amputation		5 mos. good
Levitt 1922 1	+		♀	24	1	Fair	0	0	0	0	0	0	0	Rt.		Radical ampt.		Good
2	+		♀	39	1	Good	0	0	0	0	0	0	0	Rt.		Partial Removal		Good
Hamilton 1920 1		+	♀	44	+	Fair	Lungs	+	0	+		+	0	Rt.	Caseation	Radical ampt.		18 mos. good
Gatewood 1916 1	+		♀	36		.....	0	0	0			+	+	Rt.	Confluent tuberculous	.....		.....
2	+	+	♀	26		.....	Lungs	0	0			0	+	Rt.	" "	Amputation		Recurrence
3	+		♀	37		Good	0	+	0	+	+	0	+	Rt.	" "	Amputation		.....
4	+		♀	46		Good	0	0	0	+	+	0	0	Lt.	" "	Amputation		.....
5		+	♀	44		Poor	Lungs. Lymph-nodes	0	+	+	+	0	0	Lt.	" "	Partial ampt.		Recurrence

TUBERCULOSIS OF THE MAMMARY GLAND

[illegible]

TABLE II.
Summary of Barnes Hospital Cases

	Primary	Secondary	Sex	Age	Family history tbc. exposure	General health	Other tbc. processes	History of trauma	Cervical nodes	Axillary nodes	Sinus	Pain	Lactation	Affected breast	Pathological type of lesions	Treatment surgical	X-ray	Good Pre-operative diag. ca.	Good Pre-operative diagnosis ca. (?)
Adding a report of 6 Barnes Hospital cases, 1925 (1912-1922)																			
Case 5042, A. B.	+		♀	32	0	Good	0	0	0	0	0	0	0	Rt.	Single fibro- tic tbc. nodular mass	Radical ampt.	0	Good	
Case 241, S. McA.	+		♀	25	0	Good	0	0	0	0	+	+	+	Lt.	Cystic cavity and fibrosis. Hyline changes tuberculosis	Radical ampt.	0	Good	
Case 1607, T. S.	+		♀	26	0	Fair	0	0	0	+	0	0	+	Rt.	Cystic type with fibro- sis. Tuberculous	Excision of tumor	0	Good	
Case 1245, J. S.	+		♀	23	0	Fair	0	0	0	+	+	0	+	Lt.	Fibrotic mul- tiple cystic type with sinus.	Ampt. breast partial	0	Good	
Case 2536, I. D.		+	♀	14	+	Poor	Lungs. Lymph- nodes. Bones	0	+	+	+	+	0	Lt.	Tbc. abscess with sinus.	Through and through. Drainage with local excision	0	Fair	Pt. had gen- (as to eralized tbc. breast improvement. condi-Later lost track tion) of patient.
Case 3893, M.		+	♀	32	0	Poor	Old process lungs & back. Lymph- nodes	0	+	+	+	0	0	Rt.	Tuberculous mastitis with sinus. Abscess type	Excision of sinus and portion of breast.	+	Improved from July, 1921, to March, 1923.	

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Physical Examination.—Spoken voice slightly increased over right back, otherwise negative except for breast.

The left breast exhibited a retracted nipple; just above the nipple was an ulcerated area 1 x .5 cm., covered by a thick scab. Irregular masses were palpable to the medial side of the nipple. The area about the ulcer was indurated. There were no particularly hard areas in the breast. The mass was not attached to the skin, and was freely movable over the deeper tissues. One soft enlarged lymph-gland was found in the left axilla, and a few were just palpable in the right. A few small, soft cervical glands were felt.

The diagnosis made was that of chronic inflammatory disease of the breast, probably tuberculous. The breast was removed by amputating the gland with the pectoral fascia included. Recovery was uneventful.

Pathological Report.—Specimen that of breast 10 x 9.5 x 1.6 cm., upon section a yellowish-red fatty tissue with some fascia and muscle attached is seen. The tissue is very firm, glistening, showing many small cystic cavities in dense fibrous tissue. There is a sinus opening in the skin next the nipple which is retracted.

Microscopic: Typical tuberculous breast tissue, much fibrosis as well as active tubercles with giant cells and caseation. *Diagnosis:* Tuberculosis of the breast.

CASE III.—Mrs. T. S., female, age twenty-six, admitted to Barnes Hospital, August 21, 1916, with complaint of tumor of the right breast. The family history was negative. The patient had measles at eight years of age with no complications. At sixteen she was in an Austrian hospital with some unknown variety of eye trouble. During adult life she had been troubled with belching, constipation, and hemorrhoids. She had diurnal urinary frequency, nocturia two or three times, and often noticed puffiness under the eyes in the mornings. Her only complaints referable to the chest were palpitation and shortness of breath.

She had been married seven years, had had three children, two of which died shortly after birth, one of pneumonia, the other of unknown cause. The living child was strong and well save for persistent "sore eyes" since birth. At the time of admission the patient was presumably two months pregnant and was having regular morning sickness.

In three years before admission the patient's weight dropped from 170 to 125 pounds. Eight months before admission the patient first noticed a lump above and to the right of the nipple of the right breast. The lump was hard, not painful or tender, and had increased in size somewhat.

Physical examination was negative except for the right breast, which was more pendulous than the left and presented a visible prominence in the anterior axillary line. On palpation two masses were made out, the larger mass lying radially in respect to the nipple was 1 x 3 inches in size, nodular, definitely attached to the skin, which was somewhat reddened. The tumor was not attached to the deeper structure and there was a questionable fluctuation. The mass was not tender, the nipple was not retracted, and had no discharge. The smaller lump was not nodular, was about 1 inch in diameter, but otherwise corresponding to the larger structure. There was some dimpling of the skin, but not typical "orange peel" appearance. There was one hard bean-size gland in the axilla. The tumor was removed by simple excision, and proved to be an abscess containing yellow pus. The breast tissue itself contained a moderate amount of fibrous tissue. Animal inoculation and culture of the pus was negative but microscopic examination of the excised tissue showed tuberculous mastitis. The operative wound healed readily and the patient was well and strong in August, 1916.

Case No. 1607, T. S. Pathological report. Operation: Partial breast amputation.

Gross pathology.—Specimen is two pieces of breast tissue. The large mass has an area of skin attached 6 x 2 cm. triangular shape. The tumor mass is 4 x 3 cm. and is made up of grayish tissue, firm, and cuts with a gritty sensation. In the centre of

the mass is a cavity filled with thick yellow pus. This cavity has a well defined but necrotic wall of fibrous tissue. The smaller specimen is identical with the one described except measuring 3×2 cm.

Microscopic.—Breast tissue showing tuberculous chronic inflammation limited largely to the glandular but extending in some places into the connective tissue. In several lobules there are young tubercles with giant cells, but no caseation is seen. Many degenerating acini have been replaced by inflammatory cells. Diagnosis: Tuberculosis of the breast.

CASE IV.—Miss I. B. D., age fourteen, schoolgirl, colored. This patient entered Barnes Hospital, May 11, 1918, with a discharging swelling on the left side of the face, an open discharging area on the left hand, and a swelling in the left breast. The paternal grandfather and an aunt had died of tuberculosis and the patient was associated with another aunt who had had the disease at the time of onset of her symptoms. At the age of three the patient had an osteitis, presumably tuberculous, of the third metacarpal of the left hand with subsequent partial excision of the bone. The hand had intermittently discharged since then. At four years the left elbow became swollen, was lanced, and later healed. At six years there were swellings in both triangles on the left side of the neck; the glands were removed, the wound discharged about three months, then closed: there were several swellings which subsided. February, 1918, one such swelling opened spontaneously, then closed, and was reopened at the City Hospital in April, 1918.

In January, 1918, the patient had a small discharging sore on the left breast; it closed, then reopened just before she noticed a swelling in the breast in late April, 1918, two weeks before admission. The mass was occasionally painful.

The patient had no cough despite occasional hæmoptysis; she had frequent nose bleed.

Physical Examination.—The patient presented enlarged cervical glands on the left, and a discharging sinus in the left parotid region. The chest findings indicated extensive tuberculosis in the right lung and involvement of the left apex. There was no dyspnoea nor cyanosis. The heart presented a pre-systolic roughening, heard in the fourth and fifth I. C. S. in the left sternal line. There was a discharging sinus on the dorsum of the left hand. The arms were scarred from like sinuses.

The left breast presented an enlargement at its upper border which was circumscribed, indurated, red, painful, hot, with a discharging sinus 5 mm. in diameter. There was one lymph-gland palpable in the axilla.

Laboratory findings: White blood-cells, 15,200; hæmoglobin, 70 per cent. Wassermann: Noguchi antigen, 4 plus; alcoholic, negative. Urine: Many white blood-cells, few hyaline casts, trace of sugar (Fehlings).

Operation, May 15, 1918: Sinus above breast probed, 20 c.c. of watery pus obtained. The swollen area was apparently cavitated. Through-and-through drainage of the area was established, and a lymph-gland the size of a pigeon egg was removed from the axilla. The patient was discharged June 6, 1918, with the wound still draining, returned June 18, 1918, for dressing and observation, and was again discharged June 30, 1918, with the wound still discharging, but improved.

The fluid from the abscess was sterile. A specimen of breast tissue was not obtained, as the process was considered a pyogenic one at the time of operation. The lymph-gland was soft, cheesy-looking, and microscopically showed dense infiltration with round cells; several necrotic areas and many giant cells were seen. Diagnosis: Tuberculosis of lymph-gland.

CASE V.—Miss Q., typist, age thirty-two. Admitted to Barnes Hospital, January 5, 1920, with a mass the size of a hen's egg in the right breast. Family history was not suggestive of tuberculosis, but there was a history of protracted exposure. The patient had had a tuberculous abscess of the lower dorsal vertebræ at twenty-two, and a discharging sinus on the right forearm at the same time. She was diagnosed pulmonary

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tuberculosis at twenty-seven; observed in 1916 at twenty-eight; she had marked tuberculous lymphadenitis of the cervical glands. In November, 1919, she noticed a lump the size of a dime in the lower medial quadrant of the right breast; it enlarged to the size of an egg in one month, and growth stopped. The lump was not painful or tender. On admission, examination showed a cystic mass, freely movable, no abnormalities of the overlying skin; the nipple was not retracted. There was one palpable gland in the axilla, and a few shotty glands in the right cervical triangles. The lungs presented no physical signs of tuberculosis. Wassermann was negative; tuberculous complement fixation (blood) was 2 plus. The clinical diagnosis was tuberculosis of the breast. The patient refused to permit the removal of the breast.

At operation the mass, a pus-containing cyst, was dissected out. The pus was sterile; the tissue was pronounced free from tuberculosis. Healing was rapid.

In July, 1920, the patient returned to the hospital with an intermittently discharging sinus in the scar of the former operation, with another sinus developing near it, and a palpable gland in the axilla. No operative work was done at that time. In September, 1920, she again returned with some nodules in the skin about the sinus, which showed some attachment to the underlying structures. The sinus tracts were dissected out and the lower portion of the breast removed. There was an afebrile post-operative course; the patient left the hospital with the wound still discharging a bloody fluid. The excised tissue was typically tuberculous. The sinus continued to drain and in July, 1921, a series of X-ray treatments was begun. Between July 22, 1921, and March 12, 1923, she received 12 treatments of 25 m.a. minutes, 9-inch spark gap, 12-inch distance, with a 3-mm. aluminum filter.

The patient became uncoöperative and failed to return. When last seen she still had a small sinus (March, 1923).

Pathological Report.—Gross: Specimen consists of skin, sinus tract, and portion of tissue 19 x 8 x 4 cm. A sinus tract opens in the centre of the skin area around which is a definite area of inflammation. On sectioning this tissue lengthwise, it is observed to consist chiefly of fatty breast tissue, and a small section of muscle.

Microscopical Pathology.—Section one—simple chronic mastitis and normal tissue. Section two (nearer the sinus tract)—chronic mastitis. Section three—chronic mastitis of a tuberculous character with giant cells and a definite collection of tubercles. Diagnosis: Tuberculous mastitis.

CASE VI.—Mrs. A. B., female, white, age thirty-two; housewife. This patient was admitted to Barnes Hospital, January 18, 1922, with complaint of lump in right breast. Family history was negative. The patient had had measles at six months, scarlet fever at ten years. She had attacks of indigestion and vertigo and heart pain during adult life. Aside from this the past history was negative.

She first noticed a lump in the lower half of the right breast January 1, 1922, two weeks before admission. After this the breast became red at the menstrual period, but was not more tender than was usual at this time. The mass was somewhat broader than a silver dollar and rather flat. It was hard, and ceased to be tender with the cessation of the menstrual mammary engorgement. At first smooth, the mass later became irregular.

Physical examination was negative except for the right breast, which was the same size as the left. A bulging was seen in the lower half, 6 x 2.5 x 2 cm. The mass was freely movable, not attached to the skin, elastic, firm, and fairly smooth. The nipple was not retracted, and exhibited no discharge. No cervical or axillary nodes were palpable. The condition was diagnosed carcinoma and a radical amputation was done. Complete closure was obtained, and recovery was uneventful. Microscopic examination showed tuberculosis of the breast and of the one lymph-gland removed.

Pathological Report.—Operation.—Excision of the breast, radical. *Gross Pathology.*—Specimen consists of breast, pectoral muscles, fascia and axillary glands. The

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skin measures 13 x 14 cm. There is a stony hard mass in the glandular tissue which is not encapsulated, measuring about 3.5 cm. in diameter. The skin is not attached and there is no dimpling. The mass is opaque, white, and cuts with a gritty sensation.

Microscopic Pathology.—Slide shows multiple tubercles with necrotic centres, fibroblasts, endothelial cells, giant cells, and small round cells. No breast tissue seen but there is considerable fibrous tissue. Lymph-glands showed endothelial hyperplasia and a tubercle.

Diagnosis: Tuberculosis of the breast.

ANALYSIS OF THE CHART OF THE 39 CASES BETWEEN 1914 AND 1924

Primary Cases: 25.

Secondary Cases: 14.

Sex: Males, 2 (both secondary).

Females, 37.

Age: Youngest: female, 13.

Oldest: male, 52.

The oldest female was 49.

Age limits of the two groups:

Primary: Oldest, 49; youngest, 13.

Secondary: Oldest, 44; youngest, 14.

Year groups:

10 to 20, 2 cases; 1 primary, 1 secondary.

20 to 30, 18 cases; 11 primary, 7 secondary.

30 to 40, 10 cases; 8 primary, 2 secondary.

40 to 50, 8 cases; 5 primary, 3 secondary (1 male, aged 44).

50 — 1 case; secondary, male.

Family History:

Five secondaries were positive.

One primary was positive.

General Health:

Primary, 20 had been good, 5 fair, none poor.

Secondary, 1 good (tuberculosis of knee 10 years before); 3 fair, 9 poor, 1 not given.

Other tuberculosis processes present: in secondaries:

2 had lung and lymph-node involvement.

1 had tuberculosis of spine, radius, and of lungs and lymph-nodes.

1 had a tuberculous knee (10 years before).

1 had lung and empyema (tuberculous).

1 had tuberculosis of rib.

8 had tuberculosis of lungs alone.

History of Trauma:

1 secondary positive.

4 primary positive.

Sinuses Present:

Primary cases: 16 cases (4 not reported).

Secondary cases: 5 had sinuses, 2 did not, and the remaining 7 were not reported.

Pain at any time:

Primary: 11 cases had pain, 9 did not, and the remainder were not reported.

Secondary: 5 had pain, 6 did not, and the remaining 3 were not reported.

Lactation:

Primary: 10 primaries had lactated, 6 had not, and the remaining were not reported.

Secondary: 1 secondary had lactated, 7 had not, and the remaining cases were not reported.

(Subtracting 2 males, 5 females had lactated.)

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Affected Breast:

Primary: 12 cases were of the right breast, 13 of the left.

Secondary: 6 cases were of the right, 8 cases were of the left breast.

Type of Lesion:

There is not enough uniformity of terminology to permit any analysis of the types of lesion.

Treatment:

Primaries: 4 radical, 9 simple amputations, and 6 local excisions.

Secondaries: 1 radical, 3 simple amputations, and 4 local excisions.

X-ray was used in one case (Miss M. Q.) of our series.

Results:

Primaries: 14 were good with no recurrences. The remaining 11 were not reported.

Secondaries: 4 good, 2 much improved, and 2 recurrences. The remaining 6 are not reported.

In further consideration of the analysis it may be pointed out that the male reported by Durante and MacCarty was a case of pulmonary tuberculosis with empyema; it therefore seems that the tuberculous process in the breast was one of continuity rather than a true tuberculosis of the mammary gland. Elkin also reports a female in which the process was secondary to a tuberculous rib. At operation the sinus tract and the rib were removed. Deaver has also admitted such cases to his classification. The question arises as to the justice of calling these cases "secondary" mammary tuberculosis when they appear to be simple extension by continuity.

By way of contrast to the above two cases, the case of Miles is considered—a female, aged forty-nine, who is considered as secondary because of a tuberculous condition of the knee ten years previous to the mastitis. There was no demonstrable tuberculous lesion in extra-mammary tissue at the time of her breast involvement. Gatewood believes that the usual report of 60 per cent. of mammary tuberculosis as primary is wrong, and he suggests the term "deuteropathic" to replace "primary," believing that tuberculous mastitis is similar to tuberculosis of the kidney—secondary to some focus which may be, and usually is, unrecognized. This is in accord with Deaver's opinion, previously stated.

More than half the observers have considered the hæmatogenic route as the chief means of infection of the breast with tubercle bacilli. Elkin states that in order for the lesion to be primary the organisms must enter the skin, the mucous membrane, or must be in the blood without causing lesions elsewhere. This is also in accord with Deaver's statements. Elkin and others quote Babes, indicating the possibility of tubercle bacilli gaining entrance through an intact skin, and Ravenel in regard to the passage of the organisms through the intact intestinal mucosa. Some have thought that the lactiferous ducts furnish a pathway of entrance for the infection; of the cases in which lactation was reported, 10 primary cases had lactated and 6 had not; 1 secondary case had lactated, 7 had not.

Retrograde involvement from the lymphatic tissues of the region would appear to be a frequent occurrence in secondary cases, and there is to be

observed a high incidence of palpable axillary or cervical nodes, but demonstration as to whether the glandular enlargement preceded or followed the mammary involvement would be very difficult.

Trauma plays no considerable part except in one case—a thirteen-year-old girl of Cahill's series. However, 3 other primary cases and 1 secondary case present a positive history of some injury.

It is of importance to note that the general health of the patients was good, and that only one primary case gave a positive family or exposure history. Five secondary cases gave positive family or exposure histories.

Considering the concomitant lesions, assumed to be the original foci of infection in the secondary group, the most frequent finding was involvement of the lungs alone; next to this in frequency was involvement of lungs and lymph-nodes.

The types of the lesion accepted by Deaver and McFarland have been listed previously in the paper. Their characteristics are as follows:

(1) Acute miliary tuberculous mastitis is always secondary and is of little surgical importance since it is a part of a general miliary tuberculosis.

(2) Nodular tuberculous mastitis presents a breast containing discrete nodules, and is considered to be due to the bacilli lodging in the stroma of the gland rather than in the duct or peri-ductal tissue. Localized tubercles form, gradually increase in size, and coalesce, forming a palpable mass which is as a rule not attached to the deeper structures and is not at first connected to the skin. These masses are irregular in contour and may present fluctuation. They are tender in many cases. Formation of cicatricial tissue causes the nipple to be retracted quite commonly. The skin eventually becomes involved, adheres to the mass, and turns dark red in color. Following this the abscess points and ruptures.

(3) Disseminated nodular tuberculous mastitis is a spreading variety of the above type and is seen most commonly in breasts that are lactating.

(4) Sclerosing tuberculous mastitis presents a maximum of connective tissue formation. Sinuses are not common in this variety.

(5) Mastitis tuberculosa obliterans has the lesion chiefly surrounding the milk ducts, destroying the epithelial lining, and filling the lumen of the duct with the debris.

Gatewood grouped all his five cases as "confluent" in type. This type is rarely confused with any condition other than actinomycosis or tertiary syphilis, and is more common than either of these in the breast.

Durante and MacCarty describe their gross pathological picture as one of chronic mastitis with dirty discoloration of the normally pearly white glandular tissue, and a bloody discoloration of the fat. Microscopically, fibrosis about localized areas of caseation which showed lymphocytic infiltration and giant cells, formed the picture.

Elkin uses the following terminology: (a) Disseminated, (b) confluent, and (c) sclerosing types.

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In regard to treatment and prognosis, Cahill states that complete removal of the breast and pectoral muscles with dissection of the axillary glands is indicated if the glands are involved, while if the disease is early and no glands are involved and the sinuses have not reached the pectoral fascia, complete removal of the entire breast tissue will suffice; post-operative X-ray may be indicated.

In the primary cases there were 4 radical, 9 simple amputations, and 6 local excisions. In the secondary group there were 3 simple amputations, 4 local excisions, and 1 radical operation. In one of our own series (Miss M. Q.) X-ray was used. This patient would consent to only a local excision of the lesion, and received the post-operative radiation indicated in her history.

Two of our cases had radical amputations—Mrs. A. B. had a pre-operative diagnosis of cancer and Mrs. McA. was considered as having a possible malignancy. The two other primary cases had (a) excision of the tumor and (b) partial amputation of the breast with good results. One secondary case, Miss I. B. D. was suffering from a generalized tuberculosis and drainage was carried out as a palliative measure. The sinus did not completely heal until June, 1919. In late June of 1919, the patient had an amputation of the left arm because of tuberculosis of the elbow, at which time she also had marked cervical lymphadenitis. Shortly thereafter, she moved from St. Louis and has since been lost to our Social Service department.

Tuberculosis of the breast is one of the most benign forms of tubercle infection. The treatment is surgical, and prognosis is excellent in the primary cases if surgical intervention occurs while the process is still confined to the mammary gland, before the lymph-glands of the region break down. The prognosis of the secondary cases is fairly good for the immediate lesion; the ultimate prognosis obviously depends on the other foci within the body.

NOTE: This article was completed before the appearance of the following papers: Tuberculosis of the Breast by J. W. Hinton and T. C. Lawson (*ANNALS OF SURGERY*, 1926, vol. lxxxiii, p. 170); Tuberculosis of the Mammary Glands by Cahill, James A. (*Surg., Gyn. and Obst.*, vol. xi, p. 227, 1925); Tuberculosis of the Mammary Gland by Shipley, A. M., and Spencer, H. R. (*ANNALS OF SURGERY*, 1926, vol. lxxxiii, p. 175).

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ON THE SIGNIFICANCE OF THE ESCAPE OF STERILE BILE INTO THE PERITONEAL CAVITY

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THE ominous import of the discharge of infected bile into the peritoneal cavity following perforations in the inflamed extra-hepatic bile passages is generally conceded. McWilliams,⁶⁹ in reporting 108 operated cases of spontaneous perforation in the infected biliary system, states that the mortality was 48 per cent. In a study of peritonitis by Hirschel,⁴⁶ seven of the cases reported were due to perforations in the biliary tract. All died. J. F. Erdmann²⁹ has compiled thirty-four instances of spontaneous perforation of the gall-bladder during typhoid fever. Twenty-seven were not operated on. All died. Of the seven submitted to operation, four recovered. Noetzel⁷⁸ states that eleven cases of spontaneous perforation of the gall-bladder have come under his observation, six of which died. In an experimental investigation he established peritoneal-bile fistulæ in dogs and at the same time introduced bacteria into the peritoneal cavity. In almost every instance death quickly supervened due to a fulminant peritonitis. When bile alone was allowed to drain into the peritoneal space, or bacteria alone introduced, no untoward effect was observed. The malignant character of biliary peritonitis needs no emphasis.

The significance of the escape of sterile bile into the peritoneal space is not so generally agreed upon. Some of the early writers on this subject believed that the escape of bile into the peritoneal cavity was regularly followed by a fatal outcome. More recent observations would lead us to believe that the leakage of bile into the peritoneal cavity is attended with no great danger. Some state that sterile bile in the free peritoneal cavity is absolutely innocuous.

Larrey⁸⁰ wrote "Le epanchement des matieres bilieuses dans la cavite abdominale est mortel." John Bell⁴ considered the escape of bile into the peritoneal cavity more dangerous than fæces or urine. Hennen said, "Nie ist Jemand meines Wissens von einer Verwundung der Gallenblase genesen." Duputryen⁸¹ believed that wounds of the gall-bladder were regularly fatal from peritonitis. Chelius⁸² stated that only with localization of the escaped bile, the establishment of an external fistula or removal of the bile by puncture was a favorable outcome possible. Guthrie⁸³ said "wounds of the gall-bladder are as far as is known, fatal."

In 1879, Thiersch⁸⁴ reported before the German Congress of Surgery the instance of a boy of twenty who died seven weeks following receipt of an injury to the biliary passages: three litres of bile had been aspirated. The only other instance of death following rupture of the biliary passages that had come to his attention was the case of Drysdale,⁸⁵ where death occurred fifty-three days after rupture of the common bile duct. It was his opinion that the escape of sterile bile into the peritoneal cavity was attended with no great danger. Lesser,⁸⁶ in discussing the case of Thiersch, reported on some experimental work done by Bostroem which would indicate that large amounts of bile in the peritoneal cavity are innocuous. In 1892, in an editorial article in the

ANNALS OF SURGERY, Samuel Lloyd⁶⁷ stated that no deleterious effects result from the escape of bile into the peritoneal cavity. In the same journal is abstracted a case report of Hermes⁶⁸ from the *Deutsche Medizinische Wochenschrift* in which a successful outcome is reported following operation for the escape of bile into the peritoneal cavity after trauma to the biliary tract. The editor appends the following note: "This is an admirable illustration of the comparative harmlessness of the escape of bile into the abdominal cavity and corroborates the instances reported in the editorial in the August ANNALS."

Before the Philadelphia Surgical Society in 1904, J. H. Jopson⁶⁹ and W. J. Taylor⁷⁰ reported cases of spontaneous rupture of the gall-bladder associated with unusual toxic symptoms. In both these instances, however, calculi were present and the bile presumably infected.* Both patients recovered. LeConte, at the same time, in reporting another instance and discussing the cases of Jopson and Taylor, stated "that so many cases had been reported where bile was present in the peritoneal cavity without producing profound toxic symptoms that one must eliminate many other factors before concluding that such toxæmia is caused by the peritoneal absorption of bile." In the same discussion, W. J. Hearn⁷¹ gave it as his opinion that bile in the peritoneal cavity produces no more toxic effects than does any other foreign body. J. H. Gibbon⁷² states that cases had come to his attention "where bile had been present in the peritoneal cavity for many months without producing untoward effects." He would rather believe with LeConte⁷³ that bacteria were responsible for the symptoms that developed from leakage in the biliary tract.

Cohnheim,⁷⁴ Edler,⁷⁵ Lachr,⁷⁶ and Hahn⁷⁷ believe that sterile bile in the peritoneal cavity provokes a chemical peritonitis and ascribe the untoward results occasionally observed after bile leakage to injury to the peritoneum.

Schlatter⁷⁸ says that its presence in the peritoneal cavity is well tolerated and that bile possesses absolutely no danger for the peritoneum. The danger of bile leakage he believes lies not in peritonitis, but in a toxic influence due to overloading the body with the biliary constituents.

Guibe⁷⁹ states that biliary peritonitis is a misnomer and would rather designate the accumulation of sterile bile in the peritoneal cavity as choleperitoneum. Such a condition of itself this author maintains is well tolerated and does not bring about death. The real danger in the escape of bile into the peritoneal cavity Guibe says is infection. Dormont,⁸⁰ too, states that any ill effects observed following bile leakage is due to infection. Noetzel,⁸¹ McWilliams,⁸² Orth,⁸³ Sick and Fraenkel,⁸⁴ Buchanan,⁸⁵ Ritter⁸⁶ and Burckhardt⁸⁷ state that large amounts of sterile bile in the peritoneal cavity are well tolerated.

Courvoisier⁸⁸ collected 34 instances of subcutaneous rupture of the biliary passages following trauma, of which 22 died and 12 recovered. In no instance did a patient recover without puncture or operation. Courvoisier stated that animal experiments demonstrate the harmlessness of the presence of sterile bile in the peritoneal cavity, but despite the uniform mortality in the untreated group of biliary leakage concluded that clinical experience also substantiated the idea and that bile in the peritoneal cavity when sterile was relatively harmless. That a toxic action of bile obtained through absorption be considered as being doubtful. Terrier and Auvray,⁸⁹ in a review of injury to the

* The investigations of Naunyn,⁹⁰ Leubuscher,⁹¹ Gilbert and Girode,⁹² Mieczkowski⁹³ and Mikaye⁹⁴ demonstrate that the bile of healthy animals is sterile. The contention of Fraenkel and Krause,⁹⁵ and Ehret and Stolz⁹⁶ that bacteria are present in normal bile is probably not correct. Duclaux,⁹⁷ Netter and Martha⁹⁸ and Mikaye⁹⁹ have shown that the bile in the terminal portion of the common duct regularly contains bacteria. The examination of the bile from gall-bladders that contain calculi by a number of investigators shows that bacteria are regularly present,¹⁰⁰ even though their demonstration may be difficult. Their virulence on animal inoculation is often minimal.

† Discussion of papers by Jopson, Taylor and LeConte.

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bile passages following trauma accept the conclusion of experimental investigators that sterile bile in the peritoneal space of animals is attended with no danger, but reiterate the statement of Courvoisier that no case of rupture of the biliary passages has been cured without puncture or incision.

Lewerenz⁶⁶ reported a successful outcome after rupture of the common bile duct in a boy of two and one-half years, and collected 63 other instances of injury to the gall-bladder and bile ducts from the literature. The absorption of the bile from the peritoneal cavity in these instances he considered the usual cause of death, the bile salts being responsible for the lethal outcome. Stierlin⁶⁷ also states that the resorption of bile in these instances gives rise to a fatal toxæmia when the bile flows into the peritoneal cavity for a long time. The loss of bile from the intestine he believes hastens death. Ricketts⁶⁸ combined in a report 273 instances of spontaneous perforations and traumatic ruptures of the gall-bladder and noted the better prognosis in the traumatic group. Amante⁶⁹ collected 101 instances of subcutaneous rupture of the biliary passages and states that without intervention such an injury is usually fatal, due to the toxæmia resulting from the absorbed bile. Thöle⁷⁰ in a monograph on the subject, says that spontaneous rupture of the inflamed biliary tract is much more serious than traumatic rupture of the normal bile passages. Death is due to cholæmia, loss of bile from the intestinal tract and inanition in the latter group. Kehr⁷¹ once of the opinion, that sterile bile was without effect in the peritoneal cavity, now states⁷² that continued leakage of bile into the peritoneal cavity is a serious occurrence due to the general intoxication consequent upon the absorbed bile salts. Guibe, Ritter, and more recently Burckhardt, have insisted that death from cholæmia following rupture of the bile passage has never been observed.

A number of experimental investigators have concerned themselves with this problem, and with one exception have all concluded that sterile bile may be present in the peritoneal cavity without harm. Ehrhardt⁷³ ligated the supraduodenal portion of the common bile duct in twelve dogs and cats, cut the duct above the ligature and slit the proximal end a little. His animals died within two to six days with a progressive icterus. At necropsy there was only a little bile in the peritoneal cavity. The peritoneal surfaces were bile stained, but were otherwise smooth and glistening. The bile was sterile. Death he attributed not to a chemical peritonitis, but to cholæmia from the absorbed bile. In two cats he cut a hole in the gall-bladder and placed a culture of dead *B. coli* in the peritoneal cavity. Neither of these animals died of infection or cholæmia at the end of fourteen days. Two experiments done subsequently⁷⁴ with staphylococci gave the same results. Ehrhardt concluded that bile depressed the virulence ‡ of bacteria and that infection protected against death from cholæmia.

Noetzel⁷⁵ cut a hole in the gall-bladders of seventeen rabbits. Sixteen recovered without effect. Only one died. Noetzel concluded that large cuts in the gall-bladder heal readily § and that the escape of bile into the peritoneal cavity is innocuous.

Bostroem, according to Lesser,⁷⁶ was also unable to observe any injurious effect from the leakage of bile into the peritoneal cavity of animals, and concluded that large amounts of sterile bile are well tolerated by the peritoneum and that fistulous openings in the gall-bladder close quickly.

Fraenkel and Krause⁷⁷ injected bile into the peritoneal cavity of guinea-pigs and dogs without observing any untoward effects. After cutting the gall-bladder with scissors in dogs the result was the same. When the dogs were killed two to five weeks later, the wounds in the gall-bladders had healed or were sealed with omentum or loops

‡ The delayed death in this group of animals in all likelihood was due to a localization of the process by omentum or loops of intestine. When infected bile escapes into the peritoneal cavity, the process is usually well-walled off. Sterile bile on the contrary usually escapes into the free peritoneal space.

§ Enderlen and Justi⁷⁸ have studied the repair in wounds of the gall-bladder microscopically and find that healing occurs quickly.

of intestine. It was their conclusion that the escape of bile into the peritoneal space was without danger. Kehr,³² and Terrier and Auvray³³ state that Emmert, Hering, and Villaderbo, Campaignac, Ammussat and Schwartz have made similar experiments and have concluded that the presence of sterile bile in the peritoneal cavity is without significance.

The writer believing that in the experimental animal the establishment of well-functioning fistulæ is essential to determine the significance of the escape of sterile bile in the peritoneal cavity, ligated the supraduodenal portion of the common bile duct in six dogs and cut a hole in the gall-bladder at the same time. All of these animals died within twenty-four hours. At necropsy the bile in the peritoneal cavity was sterile. In two rabbits this same procedure was done. Both died within twenty-four hours.

In four other dogs the common bile duct was divided, in two the distal end was tied, in the other two it was left open. All these animals died within forty-eight hours. In two rabbits the common bile duct was divided and the distal end left open. Death occurred within forty-eight hours.

When well-functioning biliary fistulæ are established in animals, death regularly obtains due to the toxic action of the absorbed bile. In a few instances, the peritoneal surfaces were somewhat reddened, presenting the appearance of underdone beef. This appearance of the peritoneum in traumatic rupture of the biliary passages has also been noted.¹⁰¹ Cultures of the bile from the peritoneal cavities of these animals were uniformly negative for bacteria. The irritating action of the bile salts was in all likelihood responsible for this occasional reddened aspect of the peritoneal surfaces.

Of the solid constituents of bile, cholesterol and mucin can be by fairly general consent ruled out of consideration as not being responsible for the toxic symptoms that develop following the peritoneal escape of bile. Some of the early writers believed that the bile pigments were the toxic element in bile. Notably among these were Frerichs,³² Bouchard,⁹ de Bruin¹¹ and Plaesterer.⁸¹ A more recent experimental study by King and Stewart⁸⁸ would also tend to bear out the idea that the bile pigments were toxic. These authors state that the amount of bile salts in a toxic dose of bile given intravenously is insufficient to bring out the symptoms observed. Meltzer and Salant⁷² have attributed this same toxic action of bile to the bile salts. Bunting and Brown¹⁸ ascertained that small amounts of bile injected into the peritoneal cavity of rabbits and rats were fatal. They ascribed the fatal issue to a toxic effect on the myocardium but made no attempt to determine whether the salts or the pigment was the lethal factor.

Among the early writers on this subject, Röhrig,⁸⁵ Feltz and Ritter,³⁰ Leyden⁶⁶ and Rywosch⁸⁷ believed that the bile salts were responsible for the toxic action of bile. Exhaustive investigations by Stadelmann^{94, 95} and Bickel⁶ lend tenable support to the idea that bile salts are the toxic element in bile.

Biedl and Kraus,⁷ in reviewing the toxic effects of bile, state that bile salts are strongly hæmolytic for blood. In sufficient concentration they cause a coagulation of myosin, such that muscle loses its contractibility. When

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applied to a motor nerve, convulsive movements of the innervated muscles may be elicited. If introduced intravenously a slowing of the pulse with a fall in arterial blood pressure occurs. After toxic intravenous doses, a comatose state, convulsive seizures and death are the usual sequelæ.

In the experimental animal when all the bile escapes into the peritoneal cavity death ensues quickly within twenty-four to forty-eight hours. When reference, however, is made to reports of cases observed clinically in which the common duct was ruptured and a condition present analogous to that in the experimental animal just mentioned, a very different sort of situation is seen to obtain. Meissner²¹ collected 12 cases of injury of the common bile duct. Eight, or 75 per cent., of these died, but in only one instance did death occur within twenty-four hours from the receipt of the trauma. Two died thirty-three days²²,²³ after the injury and a third case²⁴ fifty-three days later, when at necropsy the common duct was found completely divided.

Meissner mentions 7 other ruptures of hepatic ducts, in 4 of whom the outcome was lethal. These died from one to eight weeks after the injury.

Courvoisier,²⁵ in commenting on the cause of death following subcutaneous wounds of the biliary tract, stated that in the 34 cases collected by him only 5 died within twenty-four hours. In 3 of these, autopsy demonstrated bleeding from the liver. A sixth case died after forty-eight hours.

Landerer²⁶ aspirated a total of 35 litres of bile from the peritoneal cavity of a boy of sixteen at successive punctures with a successful outcome. Petersen²⁷ records the instance of a boy from whose peritoneal cavity 5600 c.c. of bile was aspirated and two rents in the gall-bladder successfully repaired five weeks after a wagon had passed over the boy's abdomen. Garrett²⁸ removed a total of 16 quarts of bile by aspiration from the peritoneal cavity of a man who fell across a beam. Twenty days after the injury, a tear in the posterior wall of the common duct was found at operation. Drainage was established and the patient recovered. Uhde²⁹ removed 14½ kilograms of bile by abdominal paracentesis twenty-three days following an injury in a man of twenty-nine. Thirty-seven days later 9¼ kilograms were again removed and the patient recovered. J. F. Thompson³⁰ records the instance of a man thrown from a cart from whose peritoneal cavity 4 quarts of bile were aspirated at one time. Later 5 quarts and "seven or eight times several quarts of bile were removed" with a favorable outcome following operation.

Kulenkampff,³¹ Waugh,³² Kehr,³³ Willard,³⁴ Barling,³⁵ Garre,³⁶ Dirk,³⁷ Hildebrandt,³⁸ Fryer,³⁹ Barlow,⁴⁰ and others, have reported instances where bile was present in the peritoneal cavity for a long time following rupture of some portion of the biliary tract. Large quantities of bile were evacuated at operation or removed by puncture often at a date remote from the time of injury and the patients recovered.

In some of these instances it is not to be doubted that a dilution of the bile probably occurred through the irritation of the peritoneum and a consequent serous exudation. However, these instances substantiate beyond doubt the fact that oftentimes large quantities of bile may remain in the peritoneal cavity over a considerable portion of time, the patient meanwhile continuing in a fairly good state of health.

It has been suggested that the only deleterious effect from the escape of bile into the peritoneal cavity is occasioned through the loss of bile from the intestinal tract.^{21, 50, 92, 90} The exhaustion and inanition that these patients present would give credence to this belief, but when it is remembered that complete external biliary fistulæ have been present in patients over a number of years without untoward effects, the loss of bile from the intestinal tract

alone can scarcely be assigned as the responsible factor for the lethal outcome when the bile escapes into the peritoneal cavity. Courvoisier¹⁷ mentions instances in which complete external biliary fistulae were present 2, 3, 5, 6, 8 and even 12 years without undue ill consequence upon the patient's well-being. Dogs in which complete external biliary fistulae are established, it is true, frequently die^{40, 96} of inanition and in patients, too, apathy and anorexia occasionally are observed when all the bile is discharged to the outside. The administration of bile salts in the form of ox bile usually remedies the condition. The occurrence of osteoporosis⁹⁰ in the bones of the experimental animal and in patients who have had complete external biliary fistulae over any length of time has been noted.

Schiff⁹⁸ early observed that when complete external biliary fistulae were established in dogs that the solid content of the excreted bile diminished markedly. The decrease in the bile salt content was similarly marked. When ox bile was fed to these animals the excretion of the bile salts increased. Stadelmann's researches^{94, 95} also corroborate these findings of Schiff. Stadelmann states that when bile salts are fed that they are excreted in the bile to two-thirds of the ingested amount within ten to twelve hours. Wisner and Whipple¹⁰⁰ have noted the fluctuation in bile salts in fistula bile with increase or decrease of food.

When bile is excluded from the intestine and lost from the body through a fistula, therefore, the amount of bile salts is markedly diminished. May the same condition obtain in exclusion of bile from the intestine alone, such that patients with total occlusion of the common bile duct frequently escape an early death from the toxic bile salts and may the same cause account for the delayed death in cases where bile escapes into the peritoneal cavity.

The normal daily output of bile salts according to Weintraud¹⁰⁵ and Biedl and Kraus⁷ is about 8 to 11 grams. If this production continued in obstructive jaundice or in biliary leakage, certainly the patient should succumb at an early date to the toxic action of the bile salts. Macleod⁹⁸ says that gall-bladder bile contains about 10 to 20 per cent. solids, whereas in fistula bile only 3 per cent. is present. Brand,¹⁰ in reviewing all the published cases that had come to his attention up to 1902 where bile had been subjected to quantitative examinations, stated that the solid content of bile in fistula cases was 1 to 4 per cent., for gall-bladder bile 20 per cent. The concentrating activity of the gall-bladder is of course partially responsible for the greater solid content of gall-bladder bile. The factor of loss of bile from the intestine to the outside, however, is undoubtedly the more significant.

Bischoff⁸ could find only .34 gram of bile salts in the urine in marked icterus. He didn't believe that bile salts were formed in less amount in jaundice, but thought that they disappeared in the blood. Kühne⁹² was unable to find bile salts in normal urine. But Stadelmann⁹⁴ says that Dragendorff and Hönne were able to recover the crystals of bile salts in normal urine. Intravenous injections of bile salts by Huppert,⁹ Leyden⁹³ and Hoppe-Seyler¹¹ demonstrate that a very minor portion of these salts are excreted in the urine. Stadelmann⁹⁴ states that bile salts have not been found in blood, even though Friedlander claims to have found .0075 grams of sodium glycocholate in 100

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grams of blood. Frerichs²⁰ could find no trace of bile salts in the blood or urine of jaundiced patients after several attempts. Thirty litres of urine were used by Hoppe-Seyler²¹ to get a qualitative test for bile salts in the urine of a jaundiced patient.

Professor Hilding Berglund²² informs me that there are no reliable quantitative methods for determining bile salts in blood and urine. We must, therefore, turn to instances in which bile salt determinations have been made on bile following prolonged occlusion of the common bile duct, in which external drainage has been established. Unfortunately such determinations are rare and subject to the criticism that the bile salt determinations were made on fistula bile, which normally is poorer in all the solid constituents of bile that is ordinary bile.

Yeo and Herroun²³ report quantitative examinations on bile of a man who had been jaundiced six months. Of the total daily output of bile only 1.28 per cent. to 1.416 per cent. were solids. Of this amount .165 per cent. was sodium glycocholate and .055 per cent. sodium taurocholate. Hammarsten²⁴ reports examinations on 7 cases operated by Lennander, in which cholecystostomy had been done. Two of these patients had been jaundiced, one about three weeks, the other six weeks. The bile salt content in all 7 cases was low. In the 2 patients who had been jaundiced no remarkable decrease over the fistula bile in the other 5 instances was noted.

In only one instance to the writer's knowledge have quantitative bile salt determinations been done on the escaped bile following subcutaneous ruptures of the biliary tract. Eight days following such an injury in a man of twenty-four, Kulenkampff²⁵ aspirated 9.6 litres of bile, again ten days later $\frac{3}{4}$ of a litre, and eighteen days afterward 1 $\frac{1}{2}$ litres more. Hausmann made quantitative studies on the removed bile for bile salts. The first specimen contained 401 milligrams of bile salts per 200 c.c. A determination on the second specimen showed only 18 milligrams present in the same amount.

In external biliary fistula the amount of bile salts excreted in the bile diminishes markedly. In obstructive jaundice and leakage of the bile in the peritoneal cavity, where the bile salts are excluded from the intestine the same condition apparently obtains.

Stadelmann²⁶ postulates a circulation of the bile salts in the organism. They are excreted through the liver, absorbed from the intestine largely *via* the thoracic duct, he believes, and then reëxcreted through the liver. Such an explanation would be inadequate to account for their seeming diminution in the escape of bile into the peritoneal cavity. The absorption from the peritoneal cavity, save in those rare instances where bile is encysted (cases of Drysdale,²⁷ Thiersch,²⁸ Ratjen²⁹ and Labrosse³⁰ would probably be unusually rapid.|| If Stadelmann had contended that the circulation of the salts was completed through the portal vein instead of the thoracic duct, it would be reasonable to assume that any exclusion of bile from the intestine would be associated with a diminution in the bile salt production. Schiff's³¹ observation that injection of bile salt into a mesenteric vein also increased the excretion of bile through an external fistula would be in consonance with such a contention.

In obstructive jaundice, in addition, the liver cells may be damaged³² so that the bile salt production does not continue even though the material necessary for its synthesis may not be wanting.

¶ Quoted by Stadelmann.²⁶

|| Sterile bile is rarely encysted, though this would appear to be the rule with infected bile. Following the escape of bile into the peritoneal cavity more than half the cases are jaundiced.

The reason for the more rapid death in the experimental animal when well functioning bile fistulæ are established probably lies partially in the explanation that human bile contains largely glycocholic acid and relatively little taurocholic acid. Brand¹⁰ found that this relationship of glycocholic to taurocholic acid in man was 1:4.5 to 1:5.4. In reports of other examinations collected by Brand, this disproportion was often as great as 1:7.3 to 8. Dog bile, on the contrary, is largely taurocholic acid. A number of investigators even deny that dog bile contains glycocholic acid. Inasmuch as the taurocholic bile salts are twelve to twenty times more toxic than the glycocholic, the quicker death in the dog should be anticipated.

As concerns the treatment of instances in which bile escapes into the peritoneal cavity following injury of the bile passages, the early removal of the bile, repair of the fistulous opening and drainage are indicated. In rupture of the gall-bladder, cholecystectomy is the operation of choice; in injury to the ducts repair of the defect. When one of the major ducts has been completely severed a complete circular suture is to be avoided because of the subsequent danger of stricture formation.¹⁰⁰ A circular suture of three-quarters of the circumference of the duct with drainage through a Kehr T catheter is the method of choice in repairing the defect. Instances have been reported where the common duct was completely severed, suture impossible and the patient recovered following tamponade alone.^{71, 86} Ligation of a severed hepatic duct, though a safe procedure in animals would seem hazardous to apply to man. After complete severance of the common duct, ligation of the proximal end followed by cholecystenterostomy has been done.⁸⁵

In most of the instances reported in the literature where large quantities of bile have escaped into the peritoneal cavity, the patient has shown marked evidence of shock, such that immediate interference would be out of the question. It is interesting, however, that death from shock is rare. Where a diagnosis of the escape of bile into the peritoneal cavity can be reasonably entertained following a severe injury to the abdomen, in which a movable effusion can be demonstrated and signs of peritoneal irritation are present, and the patient's condition such that surgical interference is deemed unwise, operation may be deferred, a diagnostic puncture done, and if bile is recovered, as large a quantity as possible removed through the aspirating needle. Numerous instances of recovery following aspiration alone have been recorded, but the virtue of such a procedure lies in this: that the patient is not subjected to a major procedure while the patient is in a dangerous plight. Through removal of the bile, repeated if necessary, his condition may be so improved that operation may be done later with but little risk.

SUMMARY

The leakage of sterile bile into the peritoneal cavity is not innocuous. The experimental animal dies of cholæmia due to the toxic action of the bile salts within a short time when well functioning biliary fistulæ from which bile escapes into the peritoneal cavity are established. The escape of any

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considerable amount of sterile bile into the peritoneal cavity of man following subcutaneous rupture of the normal bile passages, unless removed, is always fatal. No instance of recovery in such an event has been recorded without removal of the bile by operation or puncture. The cause of death is cholæmia. The loss of bile from the intestinal tract is a contributing factor, but at the same time probably also accounts for the delayed death in untreated cases, through a diminution of bile salt production when bile fails to reach the intestine. The more rapid death in the dog following the extravasation of bile lies partially in the explanation that dog bile is largely the more toxic taurocholic acid, whereas, human bile contains relatively more of the less toxic glycocholic acid.

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LIVER FUNCTION STUDIES AND THEIR CLINICAL CORRELATIONS*

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AND

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ANY surgical procedure must justify itself on the basis of the results that are obtained. In order to effect the greatest number of cures it is desirable, if not indeed absolutely indispensable, to make such studies as are available to arrive at the most accurate conclusions possible concerning the condition of the part which the surgeon wishes to subject to operative procedure. In no phase of surgery is this more important than in the surgery of the biliary tract. But, unfortunately, there is perhaps no field of surgery in which *less* data is assembled before the surgeon feels that he is ready to undertake a major surgical procedure. The results of such incomplete pre-operative study are only too strikingly demonstrated in the poor end-results that are being obtained. Any careful study of the problems of biliary tract surgery will convince even the most optimistic surgeon that the end-results that are being obtained are far from flattering. We wish to state distinctly that by end-results we mean not only relief from colic, where colic was a feature, but also relief from unfavorable reactions to fried and fatty foods, flatus, and the vague digestive disturbances that make the patient so decidedly uncomfortable. We recognize that cholecystectomy, etc., is usually successful in relieving the patient of his colic. If the operation does nothing more than this it is certainly justified. But if the patient is left with definite digestive disturbances, flatus, etc., we are compelled to recognize that the operative procedure has been only a partial success and that the end-results are unsatisfactory, or at best only partially satisfactory. If these poor end-results were being obtained only by the less experienced surgeons we might ascribe them to poor operative technic with resulting adhesions, etc., but study of this phase of the problem shows that the master surgeon also has his full share of poor end-results. For this reason we can dismiss poor surgical technic as the cause of unsatisfactory end-results, at least in a large percentage of cases.

An attempt to make a critical analysis of the underlying causes of the symptom-complex which we call cholecystitis shows that there are many who believe the principal pathological disturbance is limited to the gall-bladder and that the symptoms encountered result from this localized infection. The gall-bladder is unquestionably the chief seat of the formation of stones and so is the chief structure concerned "before the fact" with colic, since stones large enough to produce marked disturbance are seldom formed elsewhere. But where colic is not a feature there are symptoms that are encountered

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too frequently, and are too definite, to be regarded as anything else than a part of the clinical picture of the so-called cholecystitides. These patients have vague digestive disturbances, unfavorable food reactions, and a distressing amount of flatus; in fact, their attention is focussed upon these features rather than upon the colic which overshadows them in the cases with stones that have become lodged in the bile ducts.

In making a survey of the literature we find that there is an increasing amount of skepticism regarding the adequacy of a localized infection in the gall-bladder as an explanation of the clinical picture encountered in cholecystitis. Graham, Heyd, and others have shown most clearly that cholecystitis does not usually stand alone as a clear-cut pathological entity, but that there is associated, in a high percentage of cases, a significant hepatitis.

In the light of such studies we can interpret the food idiosyncrasies, flatus, etc., as due, at least in part, to an hepatic dysfunction. Where there is an obstruction of the common duct the cause for these disturbances is obvious. When fats reach the intestines they are hydrolyzed by the digestive juices to glycerol and the fatty acids. The potassium and sodium salts form soaps. These soaps and fatty acids are soluble in the bile, which facilitates absorption. If the normal amount of bile is not present, particularly the lecithin and bile acids, these fatty acids will not be so readily absorbed but will form a coating around the other food substances present, thereby delaying their digestion and allowing more time for the action of putrefactive bacteria, thus in part explaining the flatus encountered.

The recent work of Smyth and Whipple may be of interest at this point. They show that small doses of poisons which are known to affect the hepatic epithelium adversely cause a decreased output of the bile salts and acids. Since these are the really important parts of the bile, from the digestive standpoint, at least so far as we know at the present time, and since they are markedly reduced in experimental injury of the liver cells one cannot refrain from raising the question as to whether or not these salts and acids may be definitely decreased in a clinical hepatitis. And, if this be true, we have at least a partial explanation of the digestive disturbances which we so frequently encounter.

The attempt of some surgeons to belittle the effects of a hepatitis in producing a significant hepatic dysfunction on the grounds of the normally great reserve capacity of the liver hardly seems convincing in the face of the fact that a demonstrated dysfunction often does exist. In other words, theory falls down in the face of fact. Nor can the results of animal experimentation in which a large part of the liver has been removed without serious consequences be regarded as conclusive evidence that a hepatitis cannot cause a very definite hypo-function, for it must be remembered that in these experiments the liver tissue left was presumably normal tissue. A small motor in perfect condition might very conceivably handle a load that would be too much for a large motor that is in poor working condition.

Many attempts have been made to devise methods that would enable us

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to determine with accuracy just how efficiently the liver is functioning. No perfectly satisfactory test has yet been devised, for the physiology of the liver is very complex, and so an exact check upon hepatic function must necessarily be difficult to obtain. However, the phenoltetrachlorophthalein test, the icterus index (Meulengracht, Gram, Bernhard and Maue), the quantitative estimation of urobilin in the urine, and Widal's hemoclastique crisis test yield valuable data as to whether or not the liver is functioning normally and so enable us to arrive at reasonably accurate conclusions as to the approximate capacity of the liver to carry on its normal processes. Of course it does not necessarily follow that impaired efficiency of the hepatic functions which we are able to measure quantitatively is necessarily accompanied by dysfunction of the other activities of the liver. But where there is a diffuse hepatitis with dysfunction of the activities which we can measure it seems highly probable, though admittedly not proved, that the disturbance is general, even though one physiological function may be more disorganized than another.

Since the underlying principles of these functional tests are so well known to the profession, it will suffice to merely mention them here:

In the phenoltetrachlorophthalein test 5 milligrams of the dye per kilogram of body weight is injected into the blood stream and samples of blood withdrawn at the end of fifteen minutes and one hour, some laboratories also withdrawing a third sample at the end of the second hour. The amount of dye in the serum of the samples is estimated. When the liver is functioning normally the figures will be from 3 to 5 per cent. for the fifteen-minute sample and from 1 per cent. to absent in the sample taken at the end of the hour.

If significant liver pathology is present there will usually be increased dye retention. This test obviously has its limitations but Rosenthal, Green, Snell, Walters, *et al.*, have checked its results in sufficiently large series of cases to establish its value as a clinical test.

Whipple and Hooper; Mann, Bollman and Magath; Rich; Makino, *et al.*, have shown conclusively that the bile pigments may be extrahepatic in origin and that the liver merely excretes these pigments, which act as "threshold substances." If there is sufficient hepatic dysfunction this phase of normal liver physiology is disturbed and the bile pigments will dam-back in the blood stream. This may also be true where there is an obstructive jaundice.

Meulengracht, *et al.*, have devised a test whereby the degree of bile pigments retained in the blood stream can be measured. Van den Bergh has also devised a test for measuring retained bile pigments. These tests are *not* only simple, sensitive and accurate, but have the additional merit of being physiological.

The study of the urobilin content of the urine furnishes additional data as to whether or not the liver is carrying on its normal physiological activities. The bilirubin in the bile that reaches the intestine is there normally converted to urobilin (hydrobilirubin), absorbed into the blood stream and carried back

to the liver where it is re-converted into bilirubin. If the liver is not functioning normally it loses, to a greater or lesser degree, the capacity to re-convert this urobilin back into the original pigment. When this is true the urobilin is carried to the kidneys where it is excreted in the urine. An excess of urobilin in the urine, therefore, points to hepatic dysfunction.

The theory of Widal's hemoclastique crisis test may be briefly stated as follows: The split-products of protein metabolism are ordinarily stopped by the liver and broken down into harmless substances. In the presence of an hepatic dysfunction these substances may pass through the liver and give rise to a mild anaphylaxis, with a resulting leucopenia. In our hands this test has proved less reliable than the others in affording evidence of hepatic dysfunction but we feel that, if positive, it does afford additional corroborative evidence.

Feeling that Graham, *et al.*, are correct in ascribing many of the features that have ordinarily been regarded as a part of the clinical picture of cholecystitis to the associated hepatitis, we have carried out the studies upon which this paper is based. In our total series there have been 517 cases of gall-bladder disease. This report is based upon a critical study of 52 consecutive cases. In handling the patients of this series we have included an exhaustive history, a thorough general physical examination, Wassermann reaction, general blood chemistry, and the four liver function tests outlined above. The functional studies have been made at the time of admission, as often as seemed indicated during the period of pre-operative preparation, at intervals during the post-operative course, and as a final check on the end-results at some time subsequent to discharge from the hospital.

We believe that the employment of these functional studies has distinct value in handling the so-called cholecystitis cases. We feel that they are of value in differential diagnosis because patients who show symptoms suggesting non-calculous cholecystitis, but who give normal findings in the liver function studies, have generally been found to be suffering from some non-hepatic disorder. On the other hand, patients whose functional studies have pointed to definite dysfunction of the liver have almost invariably proved at operation to have definite liver pathology associated with involvement of the gall-bladder. From the clinical history, physical findings, and results of laboratory examinations we have been able to predict, with reasonable accuracy, the amount of liver pathology to be found at operation. In our series of 52 cases with complete functional studies there have been only two cases in which our predictions were not confirmed at operation.

The thing that has impressed us most in using these functional tests is the close parallelism between the severity of clinical symptoms (excluding colic) and the degree of dysfunction as shown by our laboratory studies. In our experience the phenoltetrachlorphthalein test, the icterus index, and urobilin tests have checked each other quite accurately. The Widal hemoclastique crisis has been less reliable, but we feel that it has been sufficiently valuable to justify its continued use.

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We have stressed our laboratory findings in deciding the course to be followed with any given patient. If liver function studies at the time of admission indicate marked dysfunction, he is started on a period of intense pre-operative preparation consisting of tremendous hot compresses to the liver area (Crile), a dietary régime consisting of high carbohydrate, low fat diet, and an abundance of fluids.

Within reasonable limits this period of pre-operative preparation is continued until the laboratory studies show a marked improvement in the degree of hepatic dysfunction. The patient is then subjected to whatever operative procedure that seems indicated in his particular case. In general we prefer cholecystectomy to cholecystostomy unless there is some definite indication for the latter operation or some clear-cut contra-indication for the former one. The removal of the gall-bladder, as Graham has pointed out, tends to break the cycle of infection from the liver to the gall-bladder and vice versa. When this vicious cycle has been broken the liver is better able to recover from its infection.

If functional studies at the time of operation fall within the normal zone we close the abdomen tight, without drainage of the biliary tract. The results that have been obtained by this procedure have been most gratifying. Occasionally Morrison's fossa is drained, but we feel that the adhesions, etc., that must result from this procedure render it undesirable when closure of the abdomen is not contra-indicated.

If, however, our laboratory studies show that there is hepatic dysfunction at the time of operation, we drain the biliary tract *via* the cystic duct (Lobingier). We are aware that many able surgeons claim that this method is not practicable because of the small size of the cystic duct. We have found that the cystic duct can easily be dilated with a Garceau tapered ureteral catheter to a point where drainage can be readily established, using a small drainage tube. This drainage is continued, within reasonable limits, until laboratory studies show normal values or only slight hepatic dysfunction. It is those patients with only moderate to slight dysfunction whose biliary tracts were not drained that have the food idiosyncrasies, flatus, etc.

It is thus seen that we find these liver function studies valuable in the diagnosis of hepatic disorders, in helping to decide when the patient is ready for operative interference, in indicating the desirability of drainage of the biliary tract *via* the cystic duct in preference to closing the abdomen tight or draining Morrison's fossa only, and to tell us when liver function has been sufficiently restored to discontinue drainage. We feel that these studies are of particular value in determining the length of time that is necessary to drain the biliary tract in the more severe cases.

The purposes of drainage, as we understand it, are to get rid of infection and to restore function. Surgical teachers tell us that we must drain until the bile is free from bacteria. This is doubtless all right as far as it goes, but the fact that the bile is free from bacteria seems to us to be a most

unsatisfactory criterion by which to decide whether or not the liver has been restored to something approximating normal function. Within reasonable limits, we continue drainage not only until the bile is free from bacteria, but until functional studies show values that do not vary greatly from the normal. Only 2 of the 20 cases in this series that have had cystic duct drainage have failed to be restored to normal liver-function values. Since the purpose of operation is not only to remove foci of infection, but also to restore normal function, we feel that the logic of this procedure will recommend itself. Certainly it cannot well be argued that it is desirable to discontinue drainage while liver function is in an unsatisfactory condition. Such functional studies as we are making give a fair approximation of the state of liver function and, we believe, furnish a much more satisfactory criterion than mere freedom of the bile from bacteria by which to decide when it is safe to discontinue drainage.

It is often extremely difficult to decide whether or not a patient with non-calculous cholecystitis will receive the greater benefit from surgical interference or from medical attention in the hands of a qualified internist. If a patient comes in with cholecystitis but without stones and in the usual period of preparation returns to normal liver function values, as shown by laboratory tests, he is referred back to the internist for treatment if visible foci of infection are found. Where such a mild grade of dysfunction exists we regard this as the most conservative procedure and the one that best serves the interests of the patient. With proper dietary control and by having all accessible foci of infection cleared up, these patients often do remarkably well without being compelled to subject themselves to a major surgical procedure. It is thus seen that the laboratory can afford valuable aid in deciding whether or not the borderline cases shall be handled medically or surgically.

As stated in the beginning of this paper, any procedure that is to be continued must justify itself on the basis of results. We have applied that test to these laboratory procedures, making every effort to separate fact from fancy. We have not been content to regard relief from colic as a satisfactory end-result of an operative procedure on the biliary tract, but have insisted that the patient be relieved from digestive disturbances that do not belong primarily to the gastro-intestinal tract, from unfavorable food reactions, and from excessive flatus.

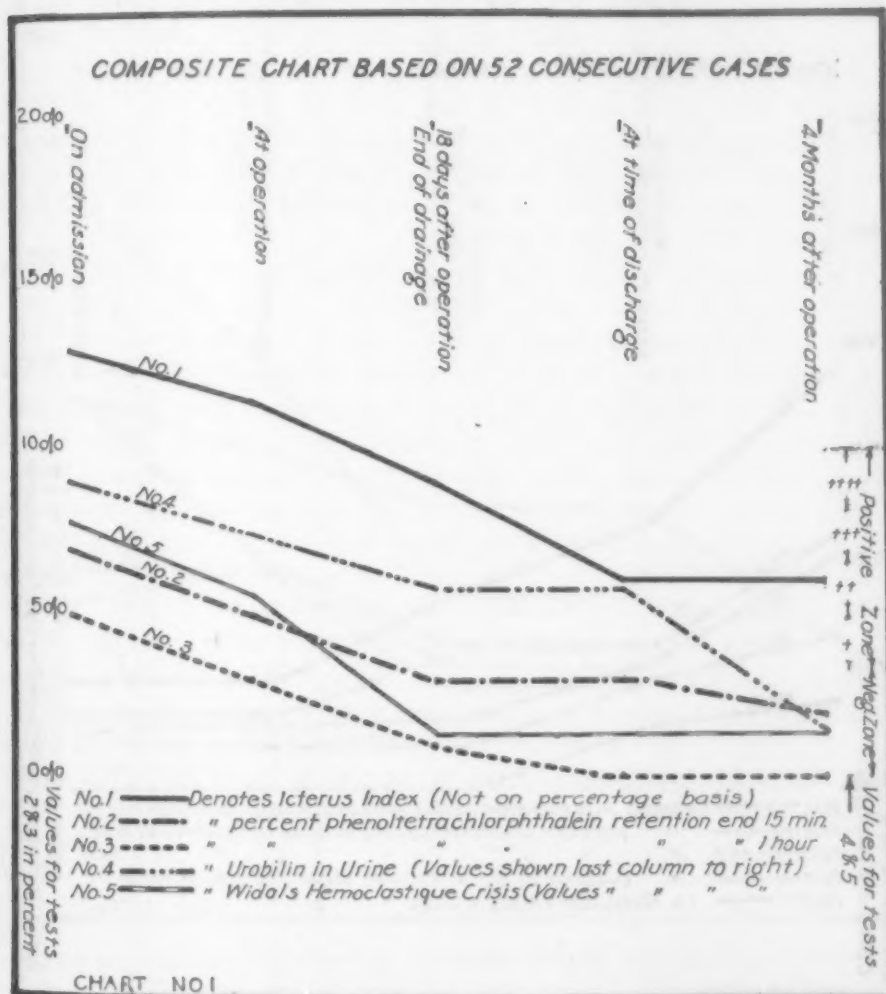
A summary of the data obtained in our series of functional studies is shown in Chart No. 1. This chart has been plotted from the average findings of *all* the 52 consecutive cases which we have included in this report and so furnishes much more trustworthy information as to the reliability of these tests than could be obtained from curves based upon selected cases.

From this chart it will be observed that the average value of the icterus index at the time of admission was 13. The average normal findings are from 4 to 7, therefore this figure is approximately double the normal value.

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Since jaundice does not ordinarily appear until values of 15 or 16 are reached, it is obvious that latent jaundice only was present in the average patient of this series. Obviously some patients were visibly jaundiced, but they represent a very small percentage of the total series.

On admission the average phenoltetrachlorophthalein retention in this series was 7 per cent. at the end of the fifteen minutes and 5 per cent. at the



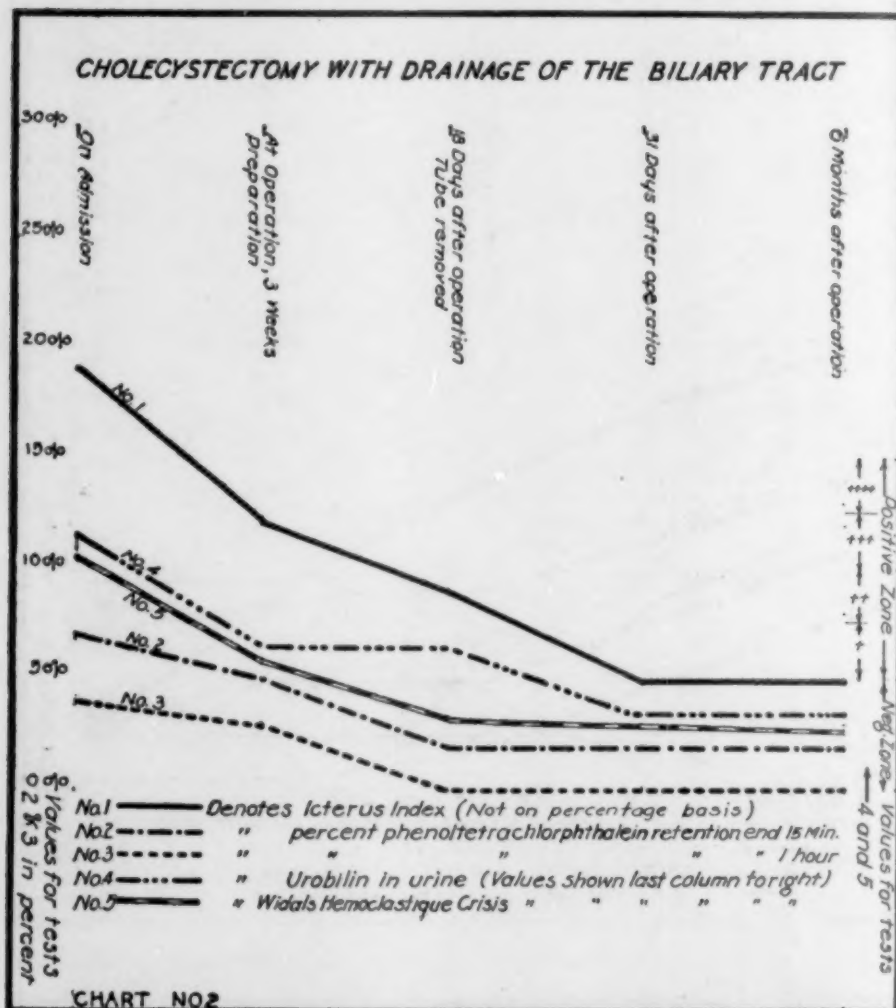
end of the hour. Since the normal value at the end of the hour period ranges from 1 per cent. to absent, it is obvious that our patients had definitely increased retention of the dye.

Urobilin was present in the urine in every case, 4 basis 4. The Widal hemoclastique crisis test was positive in 40 of the 52 cases, the average value being approximately 3 on basis of 4.

By the time the patient came to operation the average value for the

icterus index had dropped to 11.5; the phenoltetrachlorphthalein retention had dropped to 5 per cent. and 3 per cent. at the end of the fifteen minutes and one hour, respectively; the urobilin in the urine had decreased from 4 basis 4 to 3 basis 4; and the Widal hemoclastique crisis test was positive in only 25 of the 52 cases with an average value of 2 basis 4.

Eighteen days after operation, average period, the drainage tube was



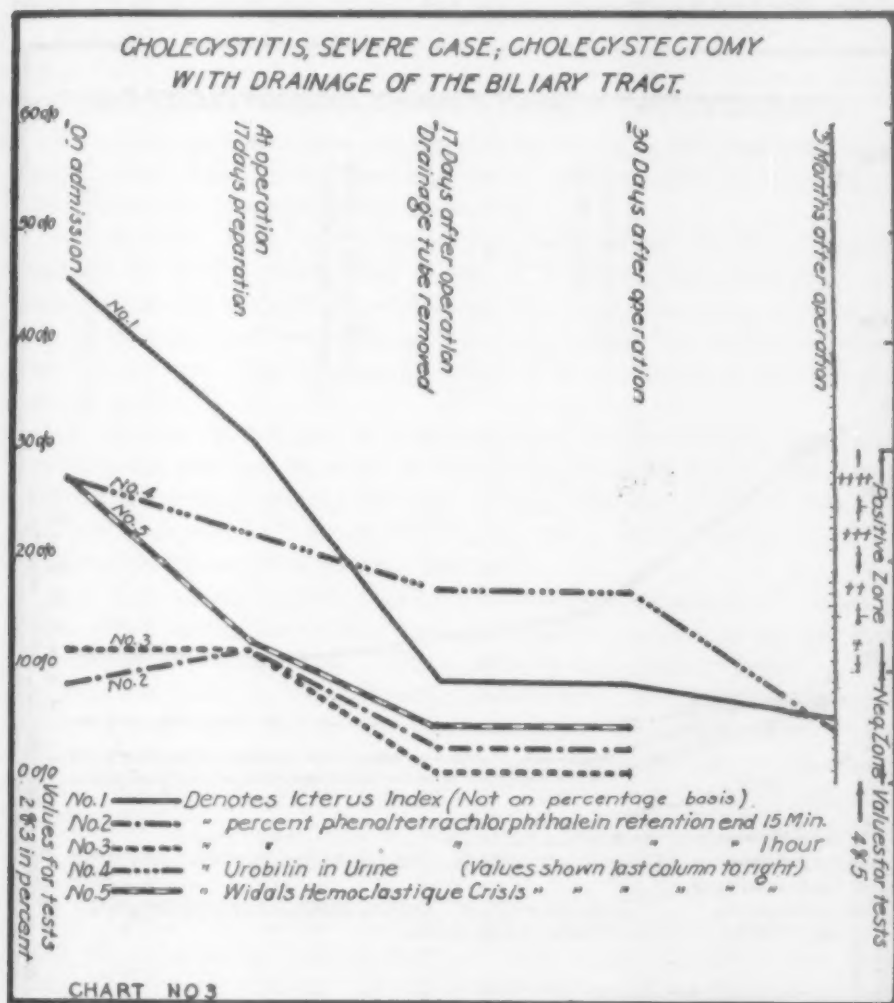
removed from those cases having drainage. At this time the icterus index had fallen to 9; the phenoltetrachlorphthalein retention to 3 per cent. and 1 per cent.; the urobilin was still consistently present in the urine but showed only a value of 2 basis 4 while the Widal hemoclastique crisis test was negative in every case.

At the time of discharge from the hospital the average icterus index had fallen to 6, a normal value; the phenoltetrachlorphthalein retention remained

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at 3 per cent. for the fifteen-minute period and was negative at the end of the hour; urobilin in the urine was still present, 2 basis 4; the Widal hemoclastique crisis test, however, was negative in every case.

A careful post-operative check of each of these patients at an average

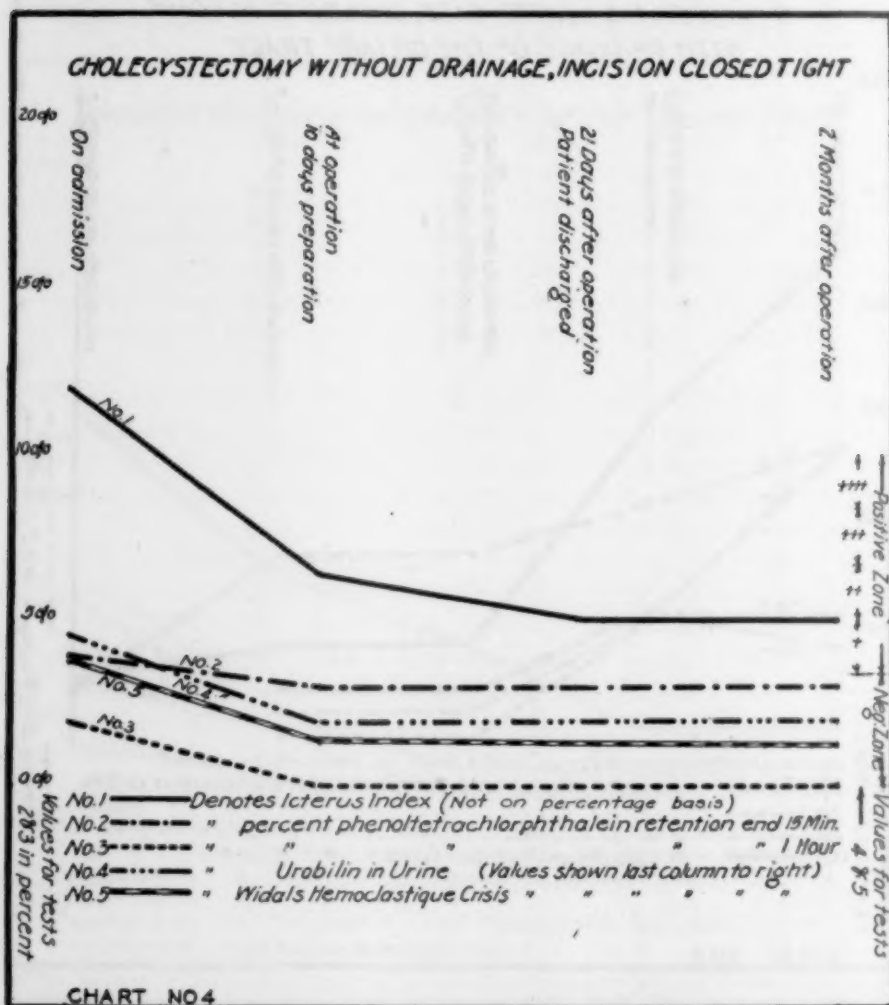


period of four months following operation showed liver function values that were well within the normal zone.

From the above data it seems perfectly clear that an hepatic dysfunction, as shown by these laboratory tests, gives abnormal values. By observing the clinical condition of these patients during their stay in the hospital, we have been able to satisfy ourselves that an improved clinical condition is reflected in more nearly normal values in the laboratory tests. With recovery the values obtained in the laboratory studies fall within the normal zone. This return to normal functional values in association with a satisfactory clinical

condition has been too consistent to be regarded as anything else than definite evidence of the value of such laboratory studies as we have been making.

Chart No. 2 shows the values obtained in the functional studies on a patient with a moderately severe, non-calculous cholecystitis, with drainage of the biliary tract. At operation the gall-bladder was found to be thickened



and hard, 3 basis of 4. The liver showed rounded edges and a marked increase of connective-tissue trabeculation, particularly in the region adjacent to the gall-bladder. Recovery was uneventful and his clinical picture checked quite accurately with his improvement as shown by the laboratory tests.

Chart No. 3 shows a severe case of cholecystitis with visible jaundice. At operation a stone was removed from the common duct which was reconstructed over a Deaver T-tube and drainage established. The gall-bladder was thickened, 3 basis 4, and filled with calculi. The liver was oedematous,

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the edges rounded, and there was a tremendous increase of connective-tissue trabeculation. The pancreas was also abnormally hard and enlarged. The appendix had been previously removed. The functional studies returned to normal values, as shown on the chart, and the patient was completely relieved of his symptoms, including food idiosyncrasies, flatus, etc.

Chart No. 4 shows a relatively mild type of case that is closed tight without abdominal drainage of any kind. At operation we found mild but definite liver pathology.

The thing that has been most gratifying to us is the close parallelism between these functional studies and the clinical condition of the patients. In checking over our end-results we find that:

(1) Patients even with severe symptoms, whose functional studies returned to normal during the period of pre-operative preparation and remained normal through the post-operative course, have been relieved not only of colic but have been free, or practically free, of the preëxisting digestive disturbances. The laboratory studies of these patients continue to give normal values.

(2) Patients who could not be restored to normal functional values before operation but who had drainage of the biliary tract until normal values were obtained, have been relieved not only of colic, but also of the unfavorable food reactions, etc. Laboratory studies give values which closely parallel the excellent clinical condition of these patients.

(3) Two of our patients could not be restored to normal liver function values either during the period of pre-operative preparation or by prolonged drainage of the biliary tract. These patients have been relieved of colic, but have continued to have digestive disturbances, unfavorable reaction to fried and fatty foods and an excessive amount of flatus. Laboratory studies show that these patients give liver function values indicating a continued hepatic dysfunction. Since these patients have been relieved of colic they would ordinarily be regarded as "cures," but we prefer to list them among our cases with poor end-results. Of course the number is too small to permit any far-reaching conclusions, but they are at least suggestive.

(4) From time to time we have patients return with digestive disturbances, etc., who had a cholecystectomy or cholecystostomy before liver function studies became routine. Of course we have no data on the state of liver function in these patients at the time they left the hospital. But laboratory studies made at the time of their return to the hospital have almost invariably given values that indicate an hepatic dysfunction and the degree of dysfunction parallels the clinical picture quite closely.

In conclusion, we feel that these functional studies afford data that makes the diagnosis of cholecystitis cases, the handling of these cases while in the hospital, and the prognosis of final results more a matter of information and not so much a mere guess. We believe that these studies more than justify themselves on the basis of results and should, therefore, be given serious consideration by every surgeon who operates upon the biliary tract.

THE TREATMENT OF PEPTIC ULCER FROM THE SURGICAL POINT OF VIEW *

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IN CONSIDERING the methods and the results of treatment of peptic ulcer the distinction between duodenal and gastric ulcers must be sharply drawn. Too often in the literature this distinction is not made, resulting in confusion and loss of value of much that is written on the subject. The late results are of the greatest importance in determining the value of methods of treatment. Certain sequelæ and complications are also of great interest in relation to the choice of method.

Duodenal Ulcer.—Medical treatment should first be tried and even repeated one or more times, for recurrence, unless there is some special contraindication, such as repeated hemorrhage, or unless the patient cannot carry out a careful diet and continue it for some time.

Until recently reports of medical treatment have not given the late results, such as have been given in many of the surgical reports. In cases treated medically the percentage of incorrect diagnoses, even when backed by X-ray examination, is considerable, resulting in a loss of value of medical statistics, as the following quotation from Reimann * indicates: "This is said intentionally to cast some discredit on the clinical diagnosis of gastric and duodenal ulcer, even when backed by röntgenological evidence, for, as appears in literature, reports of treatment and diagnosis of these conditions, without actual visualization of the ulcer, contain an error of varying amount, and, in our experience, seldom below 20 per cent." The pathologist also knows, both from surgical and necropsy specimens, that the relief or abolition of symptoms is no criterion of healing. Thus Reimann * says: "Careful examination of all the specimens removed at operation in this Clinic (Deaver's) has shown in a number, in which the external appearance has been that of healing, that the healing has not been complete. At operation a scar is seen and felt in some part of the stomach or duodenum. The appearance from the serosa is that of a healed cicatrix. We have yet to receive a specimen in which ulceration could not be demonstrated."

Nielsen ¹⁷ reexamined 239 patients two and one-half to nineteen years after medical treatment. The clinical diagnosis was based on reliable data in every case. Two hundred, or 83.7 per cent., were not permanently cured. The longer the duration of the ulcer at the time of treatment the larger the percentage of recurrences. On the other hand H. Krohn * followed 172 cases at least twenty-six months after discharge from medical treatment, in which the ulcer was evidenced by hæmatemesis or melena, and found that the prognosis depended more on the age of the patient at the onset than on the length of

* Read before the New York Clinical Society, April 23, 1926.

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time that the lesion had been present. Moynihan¹⁶ in his Hunterian lecture states that the mortality is higher with medical than with surgical treatment, taking into account the results of perforation and hemorrhage, while under treatment.

When medical treatment has failed, or there is some good reason to curtail it, gastro-enterostomy is the operation most employed. In addition Finney's or Horsley's pyloroplasty, with excision of the ulcer when feasible; or excision, with or without gastro-enterostomy, are employed by some operators. Of late there has been a tendency to discredit gastro-enterostomy and to substitute resection of the affected portion of the duodenum and the pyloric portion of the stomach.

Duodenal ulcers may be divided into certain groups which offer varying indications for treatment.

1. Small single ulcers of the anterior wall, not involving the pylorus or narrowing the lumen. These may be treated by excision, even without gastro-enterostomy, or by pyloroplasty with excision. This group is a relatively small one.

2. Chronic indurated ulcers, with or without penetration or fixation of the duodenum, but without obstruction or hemorrhage, comprise the great majority of duodenal ulcers. Gastro-enterostomy is the best operation for this group, at least as the primary one. The results disprove the contention that gastro-enterostomy is not effective when there is no obstruction.

3. The third group includes cases, mostly of long standing, where there is pyloric stenosis, causing delayed emptying and dilatation of the stomach. That gastro-enterostomy is very successful in these cases is generally conceded. As these patients often present emaciation, dehydration and acidosis, preliminary treatment by transfusion, clyses, glucose, etc., is often required, and operation under local anæsthesia is often advisable and usually easy.

4. Bleeding ulcers comprise about 14 per cent. of all ulcers. In severe hemorrhage, absolute rest and transfusion are indicated. Surgery is resorted to only when the hemorrhage is repeated, or after recovery from it, to prevent further bleeding. In most cases the bleeding is only moderate so that operation is indicated if it continues in spite of treatment. If operation is resorted to, excision of the ulcer, with pyloroplasty or gastro-enterostomy, is indicated, if feasible, or even resection. But since these patients are often bad risks and since Balfour¹ found that in 87 per cent. the bleeding is arrested by gastro-enterostomy, this may well be done as the first stage, if primary excision is not readily applicable. Hæmatemesis or melena occurred in 5.7 per cent. in 1000 cases after gastro-enterostomy at the Mayo Clinic reviewed by Balfour,² but the bleeding subsides under treatment, especially if not present before operation. In most of such cases the bleeding comes from the ulcer and not from the stoma, as I found in one case on reoperation. As Balfour² says: "Serious hemorrhage from the anastomosis must be regarded as a technical blunder for which the surgeon assumes responsibility," though Metge¹⁵ reports four deaths from hemorrhage after gastro-enterostomy.

Excision is a good operation for a small group of single ulcers on the anterior wall or those having repeated hemorrhage, but it should be combined with gastro-enterostomy or pyloroplasty, in most cases. The experience with excision in the Mayo Clinic, with or without pyloroplasty, shows that it gives no better results than gastro-enterostomy. Horsley² observed recurrence along the suture line after pyloroplasty in nearly 10 per cent. and Eusterman⁵ states that their experience with several hundred pyloroplasties has not been encouraging, at least 15 per cent. of them being later subjected to gastro-enterostomy with good results. Gastro-enterostomy is the better operation of the three and has the added advantage that it is non-destructive and can be undone.

The immediate and the end results of gastro-enterostomy for duodenal ulcer are satisfactory. Balfour² in reviewing the results in 1000 cases operated at the Mayo Clinic, ten or more years before, at a time when there was little post-operative care as to diet, etc., found satisfactory results in 88 per cent. W. J. Mayo¹³ states that gastro-enterostomy cures over 90 per cent. of duodenal ulcers, and Peck²⁰ that 90.8 per cent. of patients were permanently relieved and free of gastric symptoms after gastro-enterostomy, properly performed. Sherren² reports 92.6 per cent. of 500 cases perfectly well two or more years after operation. Not all Continental surgeons find that gastro-enterostomy fails to give satisfactory results. It gave Galpern⁷ 80.7 per cent. of good results and Schwyzer²³ 80 per cent. after four years, reduced to 75 per cent. later. Including only those cases that I operated on four or more years ago, among the 62 cases that I have been able to follow 90.3 per cent. gave satisfactory results. The average time of the follow-up period has been 32.5 months. Of the unsatisfactory results one gave symptoms of jejunal ulcer. He was operated on nine years before and had been well fifteen months when symptoms returned. After reëntering Bellevue Hospital he refused to stay for an X-ray examination. One had recurrence of ulcer symptoms five and one-third years after operation but refused to stay in the Hospital for an X-ray series. Another was reoperated for duodenal ulcer by a gastro-duodenostomy six and one-third years after the original gastro-enterostomy, having been relieved of symptoms until shortly before the second operation. When we consider the living conditions of Hospital patients as to diet and hygiene, and the prevalence of focal infection, the wonder is that there are not more recurrences. The satisfactory results include those free from all gastric symptoms and a small group (improved cases) with occasional or slight symptoms of indigestion, not those of ulcer. No operation will insure one against minor digestive disturbances that every one is occasionally subject to. Thus Mayo¹⁴ says: "In about 50 per cent. of patients who fail to have satisfactory relief the difficulty is functional and can be relieved by medical treatment."

In a large number of the failures, or even of the improved cases, many observers have shown that the symptoms are due to extra-gastric causes. In Balfour's² group of 1000 cases, mentioned above, the majority of failures

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were among the 129 cases in which the appendix was not removed. A diseased gall-bladder is often a cause of gastric symptoms. Eusterman⁵ says that in from 13 to 18 per cent. of all cases of chronic ulcer there is associated gross disease of the gall-bladder. Hence both the appendix and the gall-bladder should be examined and removed if there is gross evidence of pathology and the patient's condition justifies it. Removal of all other foci of infection, especially infected teeth and tonsils, is essential to avoid recurrence, also the diet is as important after operation as in the medical treatment, it should be continued for months and, in some particulars, indefinitely.

To obtain good results from gastro-enterostomy both the mechanics and the chemistry of the stomach must be altered, and the latter is the more important of the two. The new opening, if it is free enough, lessens the amount passing through the duodenum and reduces the emptying time of the stomach to normal limits, relieving pyloric stenosis. Pylorospasm is relieved mechanically and perhaps still more by the altered acidity.

Eusterman⁵ reports from the Mayo Clinic that the total and free acid were reduced from 40 to 60 per cent. after gastro-enterostomy. Among 285 cases showing the gastric analysis before and after operation, Sherren²⁴ found 131 with no free acid (HCl), sixty-five in which it was greatly reduced, fifty-two reduced to normal and only thirty-seven in which it was not reduced. There was no recurrence of symptoms in the first group, the end-results were satisfactory in the second, symptoms persisted in only five of the third group, while in the fourth, seventeen had symptoms, including all who had jejunal ulcer, five in number. In those of my cases whose histories show the gastric analysis before and after operation the acidity was reduced below normal in 63 per cent. and to normal in 27 per cent., the analysis being made from one month to eight years post-operative. In nearly every case where the post-operative acidity remained above normal the result was unsatisfactory. This was true of the only case of jejunal ulcer, the free acid being 61, fourteen months after operation.

A high pre-operative acidity seems to be a rather favorable factor, for 86.6 of this type in my series were free of all symptoms and only 6.6 were unimproved. The importance of the reduction of hyperacidity is generally recognized and is well expressed by Balfour,² who says: "The recurrence of ulcer after gastro-enterostomy, or in fact after any type of operation, is apparently directly associated with failure to reduce the acidity, to maintain this reduction and to provide adequate drainage." For this purpose the stoma should reach to the lowest point of the greater curvature, a point emphasized by Ochsner over and over again. Lewisohn¹¹ finds that gastro-enterostomy fails to reduce gastric acidity. In my cases where it fails to reduce the acidity to or below normal I feel that there has been some error in technic. One reason given by Lewisohn¹¹ for substituting gastrectomy in the surgical treatment of duodenal ulcers is the failure of gastro-enterostomy to produce anacidity, or even a marked reduction of acidity, except in a few cases. Lewisohn attributes the anacidity in 80 per cent. of subtotal gastrectomies to

the removal of that part of the stomach which secretes the acid. It is true that the pyloric portion produces an acid hormone, but the cardiac portion also secretes acid. Portis and Portis²¹ in experiments with a Pawlow pouch on dogs found that subtotal gastrectomy produced anacidity but the pouch continued to secrete free acid. They state that: "Our results indicate that the factor of neutralization plays the most important rôle in explaining the absence of free acid observed experimentally and clinically in the gastric secretion after subtotal gastrectomy." In other words the mechanism is the same as in a properly made gastro-enterostomy. They add that; "The artificial achylia produced may establish an entirely new and possibly harmful bacterial flora of the gastro-intestinal tract," and that "most individuals with achylia showed various intestinal disturbances."

Jejunal ulcer, the most serious sequela of gastro-enterostomy, has brought it the most criticism. The cause of it is not known. Unabsorbable sutures may account for a certain proportion. Judd⁸ says that, "unabsorbable sutures were found in 26 per cent. of 101 cases operated at the Mayo Clinic." Renton²² showed in animal experiments and in three clinical cases that the outer suture if unabsorbable, tends to work its way into the lumen of the gut and be cast off, even when it has not penetrated the mucosa. This fact has been demonstrated by many clinical observers. In this process a channel of infection is opened up, in fact a linear ulcer forms which may heal in most cases. Hyperacidity is held largely responsible by Lewisohn. This is generally due to an error in technic. Ochsner in the discussion of Mayo's and Sippy's papers,¹⁴ said that in every case operated on for jejunal ulcer he found that "the anastomosis was not at the lowest point of the stomach, usually through some mistake. If too high there will be an accumulation of acid or decomposing gastric contents, which corresponds to the conditions producing the duodenal ulcer in the first place." Failure to remove foci of infection in the abdomen (appendix or gall-bladder), or those due to the teeth or tonsils may contribute to any post-operative ulceration, and lack of long continued post-operative medical and dietary care may be another factor.

The incidence of jejunal ulcer in many large series of cases, like those of the Mayo Clinic, Moynihan, Sherren, etc., is 2 per cent. or under. Koennecke and Jungemann¹⁰ report 4 per cent. in the Goettingen Clinic. In my small series there were less than 2 per cent. In contrast to these Lewisohn,¹² among 68 patients traced four to nine years after gastro-enterostomy for duodenal ulcer, found 18 per cent. of jejunal ulcers, proven by operation, and 16 per cent. more, diagnosed clinically and by X-ray, a total of 34 per cent. A. A. Strauss⁴ reports 20 to 30 per cent. of jejunal ulcers after gastro-enterostomy and says that Karl Meyer found 25 per cent. at the Cook County Hospital. These figures suggest some special factors to account for them in addition to the causes of jejunal ulcer just mentioned. Eusterman⁶ finds a tendency to recurrence of ulcer in the Hebrew and those with a highly irritable nervous system who are intemperate in smoking, alcohol, condiments, etc., and

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Lewisohn's report is from Mt. Sinai Hospital. Pagenstecher thread was apparently used for the outer suture in most of Lewisohn's cases.

The mortality of gastro-enterostomy is low, Moynihan 0.5 per cent., Mayo Clinic less than 2 per cent. The mortality of my small series of gastro-enterostomies is 2.7 per cent., or, if we exclude one case that died of heat prostration, under 2 per cent.

The mortality of partial or subtotal gastrectomy is 5 per cent. or more, two and one-half times, or more, that of gastro-enterostomy. Is it justifiable to incur such an increased risk in the resection of half, or more, of a healthy stomach to avoid a lesser risk from jejunal ulcer? W. J. Mayo⁴ says no. "If an operation of a conservative character fails, then it is time enough." In addition gastrectomy is not entirely free of recurrence of ulcer. Finsterer² reported 6 cases in which ulcer recurred and jejunal ulcer is reported in a few cases after partial gastrectomy. There remains a small group of recurrent ulcers, duodenal, gastric or jejunal, 3.5 per cent. in Balfour's² 1000 cases, besides a few in which hemorrhage recurs after operation, in which gastrectomy is indicated. Galpern⁷ says he has come back to gastro-enterostomy, after giving it up for gastrectomy, as the former was safer and the results satisfactory.

If a few simple rules are observed in gastro-enterostomy for duodenal ulcers the mortality should be low and the poor results and sequelæ few. 1. Never do it unless the ulcer can be seen and felt. 2. Make a fair sized opening, reaching to the lowest point of the stomach. 3. Use only absorbable sutures. 4. Remove all extra-gastric causes of gastric symptoms and all foci of infection. 5. Observe as strict and prolonged a diet and after treatment as is used in the medical treatment of ulcer.

Gastric Ulcer.—Here the problem is different. The ulcers are usually larger, more indurated and more apt to be adherent to or involve neighboring organs. Hyperacidity is not such a prominent factor, hypoacidity is common and the neutralization of the free acid is not such an outstanding indication. But more important is the element of malignancy. In ulcers we find it in two forms, (a) Ulcers, usually large, 1 to 2.5 cm., or more in diameter, that show the beginning of malignancy, (b) cancers that have ulcerated so as to leave merely an ulcerated base. It is difficult to distinguish the latter by palpation from much indurated ulcers. There is a conflict of opinion, some holding that most ulcers in which carcinoma can be demonstrated are of the latter type and others that the former predominates. The exact proportion of ulcers that show malignant change is a matter of expert opinion about which expert pathologists are not in accord. The data are derived from specimens removed by excision or resection at operation. Stewart²⁵ on examining 216 clinical specimens found that 9.5 per cent. of the cases of chronic ulcer had become cancerous and in half of them malignancy was not suspected at operation. Pauchet¹⁹ found typical carcinomatous changes present in 15 per cent. of 200 consecutive gastrectomies for ulcer. Finsterer⁴ says that 26 per cent. of his recent cases of resection of the stomach for ulcer showed carcinoma.

Others think that the percentage is even under 5 per cent. Many place importance on an absence of a long previous ulcer history as indicating an ulcerated carcinoma, rather than a carcinomatous ulcer. But Ochsner¹⁸ in the discussion of a paper of Deaver's says: "Another error has crept in where carcinoma has been demonstrated at necropsy or operation and they find in these histories no reference to previous ulcer. This means simply that the history had been carelessly taken. In almost all cases where a careful history is taken a carcinoma patient gives a typical history of preceding ulcer."

But whatever may be the percentage of malignant changes in chronic ulcer the impossibility of determining at the operating table, much less before operation, the question of malignant invasion makes the wide removal of such ulcers imperative. This means that all gastric ulcers are essentially surgical, as Coffey³ says. I believe that one is justified in operating on many, if not most, chronic gastric ulcers without previous medical treatment, especially if the ulcer is of some size, 1 cm. or more in diameter. The clinical diagnosis alone of gastric ulcer is so apt to be fallacious that, as Moynihan¹⁶ says: "there are, indeed, only two certain methods of diagnosis in gastric ulcer, that of the radiologist and that of the surgeon."

Removal of the ulcer being essential in the treatment of gastric ulcer, I have operated mostly by resection during the past ten years. Gastric ulcers occur mostly near the pylorus and along the horizontal portion of the lesser curvature and this part of the stomach may be readily resected.

Of the seven gastro-enterostomies for gastric ulcer in the last ten years one was in a case where mesogastric resection had been done and a poor result was corrected by a gastro-enterostomy. A second case was subsequently resected. Taken as a whole the nineteen gastric ulcers that I operated by gastro-enterostomy have given 80 per cent. of good results, some of them strikingly good, especially where there was pyloric stenosis. One was operated with the diagnosis of carcinoma, on account of the very extensive induration. He was perfectly well fourteen years later. Such experiences are not rare. In two cases the pyloric end of the stomach was afterward resected.

There have been only five cases of excision for gastric ulcer in this ten year period, with gastro-enterostomy in all. These have been mostly for ulcers far from the pylorus; the operation is as difficult as resection, or more so, and the results not as good. Also carcinoma develops subsequently more often after excision than after resection, unless we excise with the cautery knife (Sistrunk) or destroy the ulcer by cautery (Balfour).

I have resected by the mesogastric method in nine cases, with no mortality. The immediate results are good but the late results not so satisfactory, so I have practically given it up, though many of the cases in this group were among the worst operated on as far as the pathology, symptoms and condition of the patients were concerned.

The Billroth II method is especially suitable where gastro-enterostomy has been done previously and two of the cases were of this type. The only mortality in my series of gastric ulcers has been in this group of eight; four

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(50 per cent.) having died. Two died of profound anæmia from previous hemorrhage, seven and twenty-five days after operation, and the first might have been saved if he could have had a second transfusion. A gastro-enterostomy would probably have been a wiser procedure. The other two cases died of pneumonia, one of them being an alcoholic with chronic disease of most of his vital organs. I have used the Billroth I method in only one case and was obliged to add a gastro-enterostomy, on account of stenosis of the stoma. It requires mobilization of the duodenum, which is not always feasible, but it has been more employed of late.

In sixteen cases the Polya type of resection was employed without mortality, all but one being posterior Polya's. These have given such a satisfactory convalescence and late result that it is with me the operation of choice in suitable cases of gastric ulcer, which includes all except those far removed from the pylorus. All but one of these have follow-up reports and the result was very satisfactory in all but one, who had recurrence of symptoms.

Among those operated four years or more ago there were 92.3 per cent. of good results. Pauchet¹⁹ says that the end-results are better where a large part of the stomach is removed.

No case has developed carcinoma except one, a case of excision, followed by gastro-enterostomy four months later. He was well for nearly eight years after the excision, when persistent jaundice developed. An exploratory operation, done in Colorado, revealed a carcinoma, but whether its origin was in the pancreas or the stomach was not determined.

The total mortality in these sixty-two operations for gastric ulcer was 6.4 per cent. There has been no mortality in the last twenty-seven cases, including twenty resections.

Résumé.—In considering the treatment of peptic ulcer and its results, duodenal and gastric ulcers should be studied separately. In *Duodenal Ulcers*, medical treatment should first be employed with few exceptions. In series of cases treated medically the diagnosis is subject to error in perhaps 20 per cent. and the majority of cases recur in time. Gastro-enterostomy gives good results in about 90 per cent. and its mortality is low, 2 per cent. or less. A properly reduced acidity is essential to a cure of the ulcer and this is accomplished in a large majority of cases by a properly performed gastro-enterostomy, reaching to the most dependent part of the greater curvature. Gastro-enterostomy prevents the recurrence of hemorrhage in about 87 per cent. of cases.

Jejunal ulcer should not occur in over 2 per cent. if the acidity is properly reduced, if absorbable sutures are used, if foci of infection are removed and careful diet kept up for many months. These factors also favor a good end-result.

Ulcers may recur in the stomach, duodenum or jejunum in 3.5 to 5 per cent. Such cases, and some bleeding ulcers, are suitable for resection. The reduction of acidity after resection is due to neutralization rather than to the removal of an acid producing part of the stomach. Gastrectomy has a mortality two

and one-half times, or more, greater than that of gastro-enterostomy and is not justifiable as a primary operation in all cases, only after the failure of a conservative operation. Excision, with gastro-enterostomy or pyloroplasty, is indicated in bleeding ulcers, or small ulcers situated anteriorly.

In *Gastric Ulcers* the danger of malignant degeneration demands the wide removal of the ulcer. The incidence of this degeneration is a matter of varying opinions, ranging from 2 to 30 per cent. or even more. The presence of malignant invasion of an ulcer can not be determined clinically or excluded by gross examination at operation. Gastric ulcers are essentially surgical. There are several methods of operative removal of ulcers, excision by knife or cautery, Billroth I and II, Mesogastric resection and Polya resection. The latter gives a low mortality and excellent results and, in my experience is the preferable operation.

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CONGENITAL CONSTRICTION OF THE DUODENUM DUE TO AN ABNORMAL FOLD OF THE ANTERIOR MESOGASTRIUM

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HARRIS, in 1914, first called attention to a hitherto undescribed condition; namely, constriction of the duodenum at the second portion giving rise to quite distinct if not characteristic symptoms and due to the remains of a definite embryologic structure. Cicatricial contraction, strictures of the duodenum due to inflammatory adhesions were not of course included in this class of cases. The six patients reported at that time by Harris were all adults whose ages ranged from twenty-five to fifty-six years. The symptoms had existed from a few years up to thirty years in one case.

As the condition is due primarily to the abnormal remains of a perfectly normal embryologic structure, it would seem that the presence of this condition would be manifested to a marked degree in occasional cases during infancy or youth, and that there must be a great variability in the degree

of obstructive force exerted by it on the duodenum with a consequent wide range in the intensity and nature of the symptoms produced.

Before reporting the case of an infant in whom this condition of partial obstruction of the second portion of the duodenum due to the presence and action of a congenital band remnant of the anterior mesogastrium was unmistakably demonstrable, I shall quote verbatim that portion of the original article by Harris in which he explains the origin of this structure.

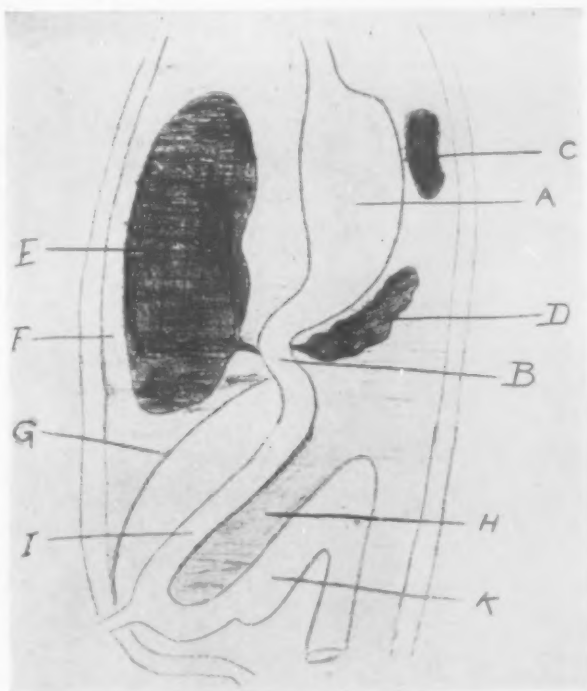


FIG. 1.—Diagrammatic representation of the development of the liver in the embryo; A, stomach; B, duodenum; C, spleen; D, pancreas; E, liver; F, anterior mesogastrium; G, caudal edge of anterior mesogastrium; H, mesentery; I, ileum; K, colon. (From Harris in *J. Am. Med. Assn.*)

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"As the fold is certainly not of inflammatory origin, we must look to embryology for an explanation of its presence. At an early period of embryonic life, when the intestinal tract is little more than a straight tube, there is an anterior as well as a posterior mesentery; but whereas the posterior mesentery extends throughout the entire length of the intestinal canal, the anterior extends caudad only so far as the proximal third of the duodenum. (Fig. 1.) In that portion of the anterior mesentery which is to lie cephalad of the diaphragm are developed the heart and some of the great blood-vessels, and is therefore called the mesocardium. That portion of the anterior mesentery which is to lie caudad of the diaphragm is called the anterior gastroduodenal mesentery,

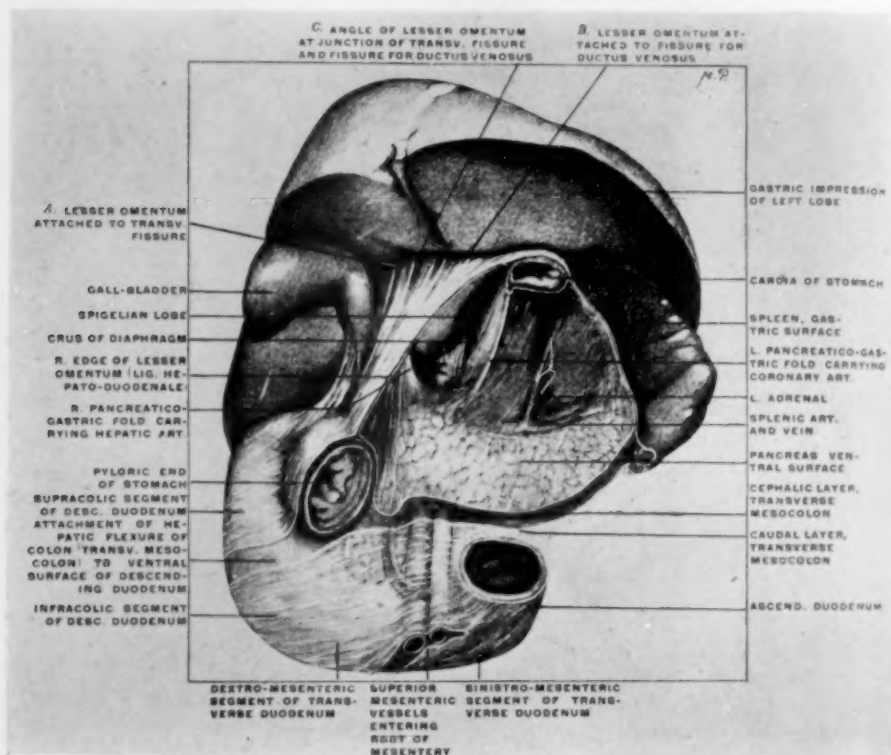


FIG. 2.—Portion of abdominal viscera of adult human subject, hardened *in situ*. The segment of stomach between cardiac and pyloric orifices has been removed, dividing the lesser omentum to this extent, but leaving the right extremity of the membrane (lig. hepato-duodenale) intact. Behind this portion the arrow passes through the foramen of Winslow. (From Huntington, *Anatomy of the Peritoneum and Abdomen*.)

or the ventral mesogastrium. In this mesogastrium the liver is developed as an outgrowth from the ventral wall of the duodenum, as shown diagrammatically in Fig. 1: The caudal edge of the ventral mesogastrium extends in an arch direction from the cephalic third of the duodenum to the umbilicus. As the liver develops, it spreads out the two layers of the mesogastrium, which eventually form the peritoneal covering of the liver, while the small remaining part which is attached to the ventral wall and to the diaphragm becomes the suspensory ligament of the liver. The umbilical vein passes from the umbilicus to the liver along the caudal edge of the ventral portion of the mesogastrium, and after fetal life these structures become the ligamentum teres.

"We are interested more particularly in that portion of the mesogastrium which extends from the duodenum to the liver after this organ has become developed, and now is given the name of the hepatoduodenal ligament. (Fig. 2) In this so-called ligament, which really consists of little else than the two layers of peritoneum forming the meso-

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gastrium, there necessarily pass the hepatic, cystic and common gall-ducts, the portal vein and the hepatic artery. As the stomach rotates to the left and the liver becomes crowded to the right, the hepatoduodenal ligament draws the duodenum upward and to the right, forming the hepatic flexure, and the turning of the duodenum to the right brings the right layer of the dorsal mesentery of the duodenum in contact with the posterior parietal peritoneum.

"Agglutination takes place with eventual disappearance of the two layers of peritoneum in contact, and this process begins at the duodenojejunal junction and extends cephalad as far as the hepatic flexure of the duodenum or the caudal edge of the anterior mesogastrium, where the process ceases. The result of this is that that portion of the duodenum which lies caudad of the hepatoduodenal ligament is practically retroperitoneal, while the portion which corresponds to the anterior mesogastrium remains surrounded by peritoneum.

"Normally, after fetal life the caudal edge of the anterior mesogastrium at its junction with the duodenum fades out and becomes imperceptibly lost in the peritoneum covering this portion of the bowel. Occasionally the transverse colon, as it crosses the duodenum in its evolution, becomes attached to the caudal edge of the mesocolon and draws it out in a fold more or less distinct, which persists and forms what is called the hepatocolic ligament. This consists of a peritoneal fold containing at times a small amount of fat between its layers, and extends, when present, usually from the gall-bladder or the cystic duct across to the transverse colon or the transverse mesocolon. Occasionally we find what was originally the left layer, but what now becomes the ventral layer of the caudal edge of the anterior mesogastrium persisting or existing as a distinct fold, extending across the ventral surface of the duodenum at the hepatic flexure and becoming lost in the peritoneum over the pancreas or in the cephalic layer of the transverse mesocolon. It was the presence of such an abnormal fold of the left (ventral) layer of the caudal edge of the anterior mesogastrium that caused the constriction of the duodenum in the cases here described."

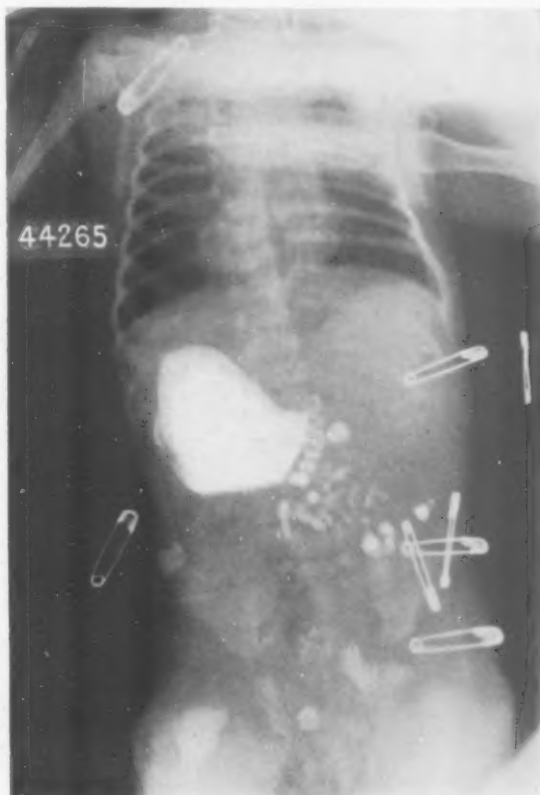


FIG. 3.—On roentgenologic examination a small but definite amount of barium was seen to pass intermittently out of the pyloric end of the stomach while the major portion of the meal remained in the stomach.

CASE REPORT

CASE 44,265, A. L. B., a female infant aged seven days, was admitted to the Clinic, April 10, 1925. She weighed 6 pounds at birth. On the third day after birth attendants noted that the child vomited repeatedly in an unnatural projectile manner. Vomiting

continued intermittently either as regurgitation immediately after nursing or projectile vomiting between feedings. The child's weight on admission was $4\frac{1}{2}$ pounds. There had been two fairly normal bowel movements since birth.

The attending physicians, Drs. H. G. Keenan and Homer Carter, suspected congenital pyloric stenosis and requested a surgical consultation, with the possibility of a Ramstedt operation in view.

Physical examination revealed a poorly nourished, dehydrated babe. No congenital defects or visible or palpable gastric distention were noted. The child was placed in a tub of warm water where it was kept for ten minutes before palpation was made under

water to insure relaxation of the abdominal walls. This failed to reveal the little tumor which is such satisfactory evidence of congenital pyloric stenosis. The temperature was 101.4. Leucocytes numbered 12,300.

Röntgenographic Examination.—Through a catheter the stomach was filled with the barium mixture and observations were made over a period of five hours. A small but definite amount of barium was seen to pass intermittently out of the pyloric end of the stomach while the major portion of the meal remained in the stomach. (Fig. 3.) It was not possible to get a satisfactory view of the duodenal cap filling. The röntgenologic report simply remarked the presence of a definite, partial pyloric obstruction. (Fig. 4.) In view of the fact that the vomiting began on the third day after

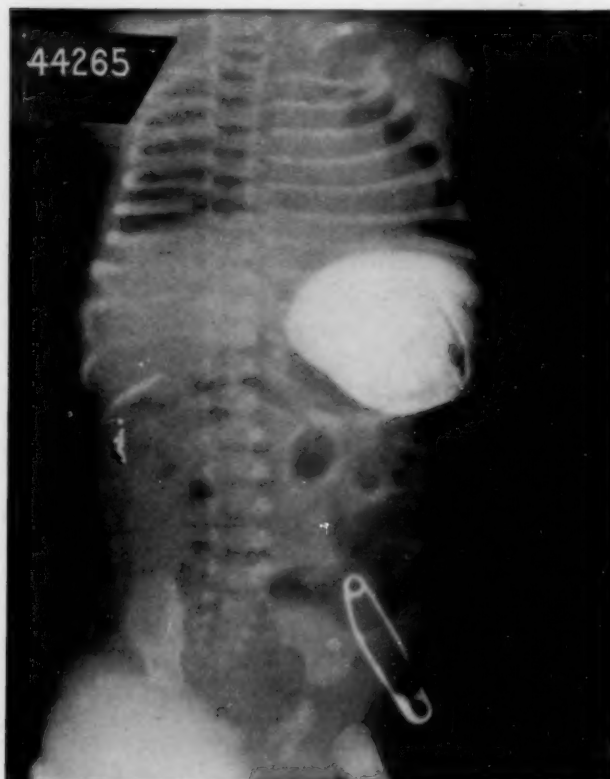


FIG. 4.—Gastric retention was reported due to definite, partial pyloric obstruction.

birth, whereas in our experience patients with true congenital pyloric stenosis practically never begin to vomit before the seventh to ninth days, and in the absence of a palpable tumor or visible peristaltic gastric outline, it was decided to await further developments before making a diagnosis.

The mother having been confined at home in another city, the babe was given a lactic acid cereal feeding by gavage at stated intervals; $1/1000$ gr. of atropine was administered ten minutes before each feeding. Twenty hours after the first fluoroscopic examination the babe was reexamined. A small amount of barium was still present in the stomach and barium was noted in the transverse and descending colon. (Fig. 5.) During the intervening hours emesis of a whitish material was noted.

Second day. Large, light brown liquid bowel movement. Repeated emesis of feedings with large admixture of bile.

Third day. Repeated projectile vomiting, bile content becoming more marked.

CONGENITAL CONSTRICTION OF THE DUODENUM

Hypodermoclysis of 150 c.c. normal saline solution every eight hours. Gastric lavage before each feeding and two ounces of cold 2 per cent. sodium chloride left in stomach at end of lavage.

Fourth day. Very little regurgitation after feedings. Retained all feedings during the night. Yellow stool.

Fifth day. Condition same as on the fourth day.

Sixth day. Material at the end of gastric lavage returned green.

Seventh day. Retained majority of feedings.

Eighth day. Condition same as on the seventh day.

Ninth day. Babe crying constantly and very much flushed. Temperature, 108° ; convulsion; child appeared in extremis; colonic flushing. Tepid bath and oxygen inhalation produced rapid improvement. Child placed on mother's milk obtained from obstetrical ward.

Tenth day. Steady improvement, babe doing well on mother's milk. Condition may be one of mal-digestion. Lavage always green at end. Babe gaining in weight. Retained all feedings.

Eleventh day. Condition same as on tenth day.

Sixteenth day. Two large yellow stools. Abdomen soft. Babe slept well and retained all feedings. Lavage green at end.

Seventeenth day. Regurgitated practically all feedings, either immediately or within one-half hour in small or large amounts.

Eighteenth day. Repeated large emesis, very green. Abdomen distended.

Nineteenth day. Inspection revealed occasional visible gastric outline with hyperperistaltic waves suggestive of phenomena of true congenital pyloric stenosis.

Twentieth day. The abdomen was carefully studied for an hour after gavage; during this time very definite energetic peristaltic gastric waves were visible and the gastric outline was clearly defined to sight and palpation. Without question there was an obstruction, but inasmuch as such large quantities of bile were so easily returned into the stomach, as indicated by the reports on the vomitus and lavages, the obstruction was considered to be below the entrance of the common bile duct, probably situated at the duodenojejunal angle, and partial in character and intermittent in action.

During the next twenty-four hours every effort was made to put the babe into the best possible condition for operation by full hydration with hypodermoclysis, gastric lavage, colonic flushings and the administration of brandy.



FIG. 5.—Twenty hours after the barium meal a small amount of barium was noted in the transverse descending colon.

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Operation.—Under local anæsthesia, a 3-inch right mid-epigastric incision was made. The stomach and pylorus were found to be normal, and there was no evidence of hypertrophy of the pyloric sphincter. The first and second portions of the duodenum were distended and simulated a prolongation of the pylorus, the sphincter muscle of which was scarcely perceptible. At a point about an inch beyond the sphincter, the duodenum was more or less hidden by a dense vascular veil or band which increased in density as it was followed in a caudad direction. It was connected at one end with the inferior surface of the right lobe of the liver and at the other with the mesocolon as shown in the diagram. (Fig. 6.) Behind it the duodenum was confined in an S-shaped position. By compressing the stomach and forcing the gas content onward, the duodenal cap

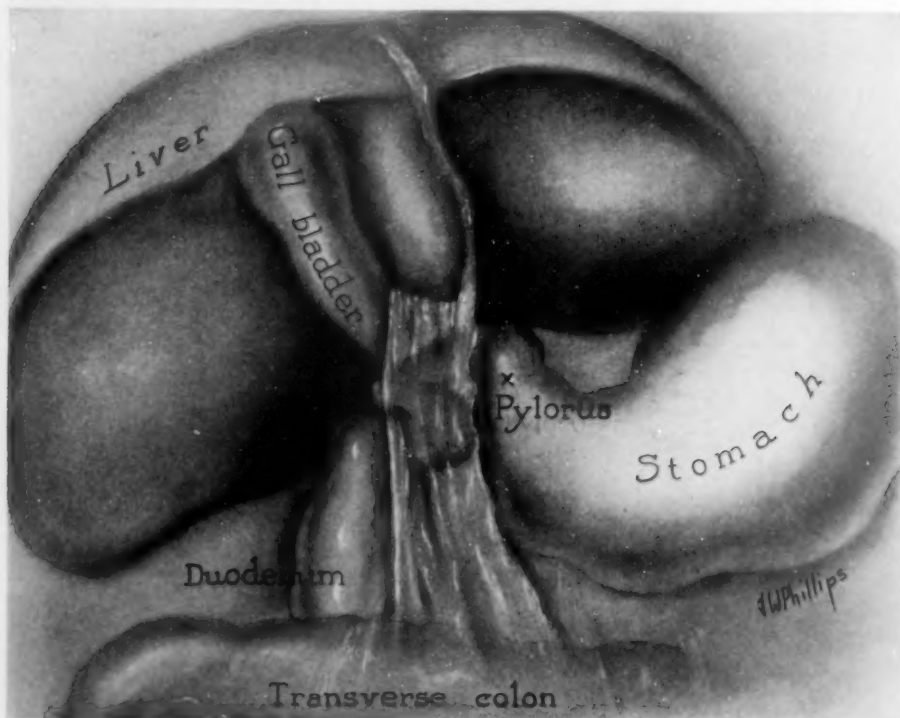


FIG. 6.—Condition at operation. The first and second portions of the duodenum were distended and simulated a prolongation of the pylorus. The duodenum was more or less hidden by a dense vascular veil which was connected at one end with the inferior surface of the right lobe of the liver and at the other with the mesocolon.

ballooned out and became physically a part of the stomach, while the confined portion of the duodenum remained in a compressed, flattened condition. On dividing the vascular, compressing band for a distance of approximately one inch, this portion of the duodenum immediately sprang into relief due to the free entrance of gas from the stomach, lost its S-shaped course and straightened out. An examination was then made of the duodeno-jejunal angle which at the moment of inspection was seen to fill rapidly with gas which freely passed on into the small intestines in a normal manner. The cæcum and appendix were noted as being in mid-epigastric position. The gall-bladder was normal.

There followed uneventful convalescence and subsequent progress with complete relief of symptoms of obstruction.

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PARALYTIC ILEUS AS A COMPLICATION OF ACUTE APPENDICITIS*

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THE spread of an intraperitoneal infection among the coils of small intestine is the first step in the development of the condition known as paralytic ileus. Diminution of intestinal muscular activity due to the irritation of the infection is followed early by distention of the gut's lumen and more or less stasis of its content. Fibrinous exudate readily mats together the adjacent inactive loops forming many kinks or sharp angulations which result in an even greater impediment to the onward propulsion of the intestinal content. Total obstruction may occur. If it does, it represents the end result of a progressive series of pathological changes dependent primarily upon the severity and extent of the intraperitoneal infection. It is important to remember that in the presence of such an obstruction there is an absence of any single definite occluded point and that with it, there co-exists an extensive lower abdominal peritonitis. In addition to this is the marked disturbance of vascular supply to that portion of the intestine involved by the inflammatory process, a feature upon which great emphasis is placed by many observers. With the control and subsidence of the peritoneal infection, absorption of the fibrinous exudate and resumption of intestinal activity usually bring about a return to normal bowel function. Paralytic ileus thus differs from any type of mechanical ileus largely because of this tendency to spontaneous resolution of the obstructing factors. Total obstruction may not occur. If it does not, it indicates that the power of resistance of the individual has been sufficient to overcome the effect of the infection upon the intestinal tract. The possibility of these two distinctly different end results emphasizes the difficulty of early diagnosis, one of the most important items in proper treatment.

Diminution of intestinal muscular activity is a fairly common post-operative complication and is recognized clinically as the patient's "gas pain" and abdominal distention. Without the element of infection, it is due to the irritation of the gut by the operative trauma and its subsidence is attributed usually to various therapeutic measures. While it is not infrequently referred to as a slight grade of ileus, this condition differs sharply from true paralytic ileus in that it never progresses to complete intestinal obstruction.

The most common source of a lower abdominal peritonitis is an acute inflammatory involvement of the appendix. The conclusions arrived at in this report are based upon a study of 48 cases of acute appendicitis which showed diffuse unlocalized peritoneal infection at the time of operation and occurred among 560 cases on the Second Surgical Division of Bellevue Hospital. Of

* Read before the New York Surgical Society, October 13, 1926.

this number 26 died and 22 recovered. Of the 22 recoveries 2 were complicated by the paralytic type of obstruction. One of these recovered with and the other without re-operation. Careful scrutiny of the records of the fatal cases leads to the conclusion that 10 of them died as the result of intestinal obstruction. Thus out of the entire group of 48 cases which showed a diffuse peritonitis at the time of operation, 12, or 25 per cent., subsequently developed an intestinal obstruction of the paralytic type. Moreover about 40 per cent. of the deaths (10 out of 26) following operation under such circumstances were due to intestinal obstruction.

Recently Handley has repeated his opinion that the cause of death in peritonitis is intestinal obstruction and that peritonitis alone does not necessarily cause death. He has concluded that the obstruction usually comes on before the peritonitis has reached the level of the umbilicus.

The follow-up record system was not established on our service until October, 1916, so that these figures cover a period of almost ten years. Until the past two or three years the tendency has been to look upon the operation of enterostomy as a last resort. As a result of this practice practically all of the earlier cases in this series which were subjected to re-operation had progressed to fecal vomiting at that time. It is believed that this delay in radical treatment may account for the high ratio of deaths to recoveries and it is now felt that such a course is a mistake and that in the presence of a severe and unlocalized peritonitis the performance of a jejunostomy for intestinal drainage may be looked upon almost as a prophylactic procedure. It is so used by us at the present time, although the decision as to the optimum time for this step is often most difficult to make.

With the onset of the average attack of acute appendicitis, nausea or vomiting occurs, occasionally recurs during the first few hours, but does not persist after this time. Persistent pre-operative vomiting signifies the patient's failure to localize his infection and is indicative of the probable development of a spreading peritonitis. The following history is illustrative of this point:

R. P., a man twenty-six years of age, was admitted to the hospital on March 1, 1926, with a thirty-six-hour history of abdominal pain. The pain was at first in the central portion of his abdomen, later increased in severity and became localized in the epigastrium. The only other noteworthy symptom was vomiting, which had been repeated and persistent since the onset of his illness. Physical examination revealed generalized abdominal rigidity and exquisite tenderness to palpation throughout. He was operated upon with the pre-operative diagnosis of perforated duodenal ulcer. The peritoneal cavity was found to contain a large quantity of thin purulent exudate whose primary focus was an acutely inflamed perforated appendix. Culture of this exudate showed a pure growth of streptococci. The peritonitis was so extensive that fibrinous exudate was found between the gall-bladder and duodenum. No duodenal perforation was present. His convalescence was slow and stormy but, in spite of his extensive peritonitis, he did not develop paralytic ileus.

Early post-operative diagnosis is masked by the anæsthetic vomiting and the already existing abdominal distention. Probably the first indication of an impending ileus is to be noted in the absence of the passage of flatus,

PARALYTIC ILEUS WITH APPENDICITIS

either spontaneously or as the result of colonic irrigations. Such an observation calls for vigorous efforts to aid in the emptying of the intestinal tract by repeated colonic and gastric lavages. The following example of the apparent efficacy of such a course may be recited:

P. B., a man twenty-six years of age, was admitted to the hospital on May 24, 1922, with a typical history of acute appendicitis of three days' duration. He had had no vomiting but had been nauseated repeatedly. His abdomen showed marked tenderness and muscular rigidity in its right lower quadrant. At operation through a McBurney incision, the right lower abdomen and pelvis were found filled with turbid exudate. The inflamed appendix was removed and the peritoneal cavity drained. Convalescence was marred by excessive abdominal distention and by vomiting of a fecal nature. These symptoms were treated by repeated gastric and colonic lavages. On the seventh post-operative day his condition was so critical that a second operation was contemplated, but after twenty-four hours of further waiting the obstructive symptoms subsided and he progressed to complete recovery.

Evidently this patient was most seriously if not totally obstructed, yet had sufficient resistance to overcome his peritoneal infection in spite of the toxæmia of his obstruction. Had a jejunostomy or other type of intestinal drainage operation been performed, that procedure would have been given credit for his cure. Although it may appear that such a case presents an argument against operative interference, it in no way alters the idea that his recovery would have been more assured had an early jejunostomy been done. Further than this, such a history points to the fact already mentioned that the paralytic type of obstruction does not necessarily go from bad to worse as does the mechanical, but with the subsidence of the peritoneal infection, may go on to spontaneous recovery. This fact, however, does not weaken the plea for early operative interference any more than does the fact that an occasional duodenal ulcer perforation may go on to spontaneous recovery.

Experimental investigation which has added greatly to our knowledge of the physical and chemical changes occurring in intestinal obstruction has failed to give a final answer as to the exact cause of death. Probably the prevailing opinion is that it is due for the most part to a profound toxæmia. (Whipple, Stone and Bernheim.) This toxæmia presumably is dependent upon the absorption of a powerfully toxic substance through the damaged mucosa at the site of or above the level of the obstruction. The toxic substance is present within the intestine above the obstruction and there is evidence to show that its major or most toxic portion is contained within the general region of the duodenum and jejunum. Since simple stagnation does not give rise to such a poison, it is felt by some observers that the severity of injury to the gut wall caused by the obstruction has an important relation to the grade of toxæmia. (Hartwell.) As the nature of this toxin is quite unknown, there is available no anti-toxic substance. The nearest approach to this type of treatment has been suggested by Haden and Orr, who noted a marked fall in the sodium chloride content of the blood early after an experimental high obstruction and who have reëmphasized the value

of the administration of chlorides in combating the toxæmia. Similarly the method of elaboration of the toxin remains undetermined, for which reason there can be taken no step toward the prevention of its formation. Information as to the method of its absorption is open to variations of opinion, the only established fact being that it is not absorbed from the intestinal tract below the site of obstruction.

Every case of acute suppurative appendicitis should be handled surgically with a view to the possible subsequent development of paralytic ileus. This calls for the minimum degree of operative trauma and an exposure least likely to favor the spread of infection. The McBurney type of incision seems to fulfill these requirements more satisfactorily than any type of right rectus incision. Treatment designed to prevent or to diminish abdominal distention should be instituted immediately after operation. This end is gained most efficiently by the replacement of local heat loss through the use of an electric light over the abdomen beneath the bed clothing, the administration of saline solution by hypodermoclysis, and the withholding of all fluids by mouth for at least twenty-four hours. If despite these measures distention and vomiting occur, repeated gastric lavages and colonic irrigations are indicated. Throughout the course of such treatment it should be borne in mind that the patient's best defense is his own power of resistance and that fatigue or exhaustion is his worst enemy. Rest, mental as well as bodily, is essential. Rest means sleep and sleep means morphine. When these efforts fail to yield a reward and the only conclusion to be reached is that a total obstruction is present or impending, clinical experience has taught us that our most valuable single weapon against the toxæmia is the institution of drainage of the intestinal tract. It appears to matter little whether this drainage takes place externally or into the normal gut below the obstruction. The organism's effort to accomplish this end is seen in the copious and repeated vomiting. Its apparent inadequacy is due perhaps to the necessary reversal of peristaltic movements plus the damage to the vascular supply of the gut's wall, but it is probably the safety valve which removes some of the toxin and conserves the patient's vitality until more effective drainage is obtained.

For the treatment of "ileus duplex," which evidently is synonymous with our conception of paralytic ileus, Handley recommends an anastomosis between the jejunum and transverse colon to which he adds a cæcostomy. Claiming that drainage externally—jejunostomy—robs the patient of nourishment and fluids, he thus empties the intestinal content into the normal gut below the obstructed area. Although his jejuno-colostomy may conserve body fluids, it does not seem that it is of marked benefit from the standpoint of nourishment. The severity of its accomplishment and its permanent nature appear to outweigh one of jejunostomy's greatest disadvantages—irritation of the skin of the abdominal wall. Bonney, in 1910, was the first to advocate this external drainage of the jejunum.

Under novocain infiltration anæsthesia exposure of a high loop of jejunum through the outer margin of the upper half of the left rectus muscle is

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reasonably simple. Usually the recommendation is made that the catheter or tube used for drainage be surrounded by jejunal serosa for a distance of two to three inches before its introduction into the gut's lumen and in addition that it be led externally through a rent in the omentum so that a comparatively long fistulous tract may result. This advice is admirable when spontaneous closure of the fistula is the desired end result. When immediate and adequate drainage of intestinal toxin is sought, it seems wiser to provide for it at the outset and to accept definitely the necessity for a later operation to close the fistula, as is illustrated in the following instance:

P. B., a man forty-one years of age, was admitted and operated upon for acute appendicitis on September 25, 1925. His pre-operative symptoms did not include any unusual amount of vomiting. His appendix was so adherent to the mesentery of a nearby loop of ileum that the blood supply to this portion of the gut was impaired during the appendectomy. Resection and removal of four to five inches of ileum with a side-to-side anastomosis was necessary. The pelvic loops of small intestine were bathed in a purulent peritoneal exudate. Seventy-two hours after operation he presented the picture of paralytic ileus and a jejunostomy was performed under novocain infiltration anaesthesia. A large calibre urethral catheter was surrounded by jejunal serosa for two and one-half inches before its introduction into the lumen through a purse-string suture. Intestinal drainage was not copious until the third and fourth days after this operation. Coincident with copious drainage his convalescence became smooth and rapid and was marred only by the irritation of the abdominal skin. The jejunal fistula contracted to a minute opening, but ultimately—December 28, 1925—required a laparotomy, under general anaesthesia, for its permanent closure.

The proposal is made that when dealing with a disturbance of such gravity as paralytic ileus the jejunum be attached to the parietal peritoneum of the incisional wound and a large rubber tube inserted directly into its lumen through a purse-string suture. Around this may be packed gauze strips which will serve to prevent further contamination of the peritoneal cavity. The tube then may be led into a drainage bottle so as to avoid skin irritation for at least a few days. Replacement of lost body fluids must be attempted by 1000 c.c. hypodermoclyses of saline solution repeated two or three times daily. The date at which the jejunal fistula may be closed will depend necessarily upon the patient's condition, but the general observation may be made that the least severe nutritional disturbance will result from its earliest possible repair.

Conclusions.—1. Intestinal obstruction of the paralytic type accounts for about forty per cent. of the deaths following operation for acute appendicitis in the presence of diffuse peritonitis and is one of the most serious complications with which we have to deal.

2. Adequate drainage of intestinal toxin externally by means of jejunostomy appears to be the most efficient means of combating its toxæmia.

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CHRONIC INTUSSUSCEPTION IN CHILDREN

A CRITICISM OF THE TERM, WITH A REPORT OF NINE CASES OCCURRING
IN CHILDREN

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THE term chronic intussusception is generally associated with a rare form of chronic intestinal obstruction, with a tumor as the exciting cause of the intussusception, and occurring usually in adults. When it does occur in children, it does so in older children. It, however, is seen in quite young children and even in infants (Still¹), and although primary intussusception without a demonstrable cause is very occasionally found in the adult, it may be said that it is quite unusual to find a tumor, ulceration or tuberculosis of the bowel, or any other demonstrable cause in the infant.

The term intussusception is generally associated in the mind of the clinician with the symptoms and signs of intestinal obstruction, together with the passage of blood and mucus per rectum. McGraw,² for instance, described a case in a boy aged seven years who had attacks of frightful abdominal pain extending over a period of four months. Intussusception was considered to be out of the question because there was no obstruction and scarcely any disturbance of digestion. At operation an intussusception of the appendix and cæcum was found impossible of reduction, resection was followed by recovery. The cæcum and appendix were of the foetal type and an enormous mesentery was present to the ascending colon. These cases of chronic intussusception do not show the symptoms and signs of intestinal obstruction, the motions are very often normal, and blood and mucus are often not present over a considerable part of their duration, and may not be present at all. Hence errors in diagnosis are made, and the true state of affairs is not recognized until too late, not until, in fact the invagination of the bowel is irreducible, that is, it has become "*permanent*" and cannot be reduced post-mortem, let alone by any surgical procedure. In the Tenth Edition, 1913, of Goodhart and Still's³ "*Diseases of Children*," it is stated that an "intussusception may exist without any constipation, without the passage of any blood or mucus, and, indeed, without any characteristic symptoms of any kind." Waugh⁴ has pointed out that "excessive mobility of the cæcum on account of an abnormally long mesentery to the large intestine is generally found to be present in these cases." This is the key to the absence of the characteristic symptoms and signs of intussusception. He goes on to say, "if the whole of the large intestine retains its primitive mesocolon, the apex of an intussusception may travel as far as the rectum without damage to the circulation of the gut wall, and consequently without the onset of paralytic obstruction. Reflex vomiting, however, may be so severe as to threaten the life of the patient." Gaymer-Jones,⁵ in a recent paper, recognized that the chronicity

TABLE I.
Table of Cases.

Case	Age	Sex	Surgeon	Duration	Colic	Vomiting	Bowels	Blood and mucus	Tumor	General	Operation	Mobility of colon	Result
1	9/12	M.	Mr. Addison	2 months	Two months ago attacks on and off for fortnight. Frequent for six weeks. Three days ago had a violent attack with screaming started; continued since	Started three days ago, intermittently. At first green, then like water	Stools "dark", at one time otherwise natural	Blood only after medicine ordered by doctor three days ago. Good deal since	On admission, 9/8/10. In left iliac fossa. Mass felt per rectum	Fair	9/8/10. Clear fluid, caput ceci variety reduced with difficulty. Cystic mass size two broad beans in mesenteric ileo-caecal angle	Very long and lax mesentery to caecum	March, 1925.* "No trouble since, at present picture of health."
2	11 yrs.	M.	Mr. Fairbank and Mr. Waugh	3 months	Started with attack lasting half hour; pale, ill, weak and faint. Frequent attacks fortnight, got well but occasional attacks for six weeks, when another severe attack lasting three days. Four days ago recurrence with frequent attacks five to ten minutes each	During attacks	Diarrhoea during attacks	Loose stools containing mucus and stained with blood on day of admission only. Shortly after admission, blood and mucus without faeces	On admission, 20/1/20. Firm sausage shaped in line descending colon, slightly tender	Refused food and lost weight rapidly. Listless, thin, anaemic	20/1/20. Caput ceci variety, in transverse colon, reduced easily	Caecum high. Descending colon large and flabby, very long mesentery to caecum, ascending and descending colon	11/6/20. Coloproctopathy by Mr. Waugh. Severe degree of mobility of colon. Prognosis poor. March, 1925.* Does not always appear well."
3	7½	M.	Mr. Waugh	3½ months	Stabbing pain referred to umbilicus intervals of a week, lately more frequent; borborygmi often present	During attacks at first lately nausea and retching only	Tendency to constipation relieved with purgatives. Diarrhoea with last attack	Blood three times only, once bright red	Mother noticed "Lump" across navel during attack. On admission 16/4/20 mass across epigastrium. Abdomen uniformly distended, visible peristalsis. Free fluid detected	Thin, pale, delicate appearance. Frequent micturition without pain	24/4/20. Large quantity slightly yellow free fluid. Mass rolled up in omentum across upper abdomen. Considered tuberculous; abdomen closed	No note in case report	Death 27/4/20. P.M. General suppurative peritonitis. Irreducible ileocaecal intussusception reaching to splenic flexure. Perforation outer wall (Fig. 1). Tumour at apex. Lympho-sarcoma.

CHRONIC INTUSSUSCEPTION IN CHILDREN

4	5 yrs.	M. Mr. Waugh	9 weeks	Intermittent colic, increasing last six days, severe last two days	Occasional last six weeks	Constipated first six weeks	Streaks of blood and slime last three days.	On admission, 7/3/21, palpable left iliac fossa. A few inches from anus almost gangrenous	Well nourished, in considerable pain, pulse barely palpable and uncountable	7/3/21. Free fluid ileo-caecal variety. Apex pushed up and all reduced except last portion. Entering and enlathering layers sewn together. Base of appendix visible. Removed	Marked mesenteric entry to ascending colon	March, 1928*. "Quite well since discharge from hospital."
5	7 yrs.	F. Mr. Waugh	3 months	Sudden onset colic with diarrhoea, attacks worse last month. Frequent hiccough and belching	Two or three times only	Alternating diarrhoea and constipation	Absent	Mother noticed "lump" by side of navel during severe attacks. On admission 12/4/21. Two masses felt, (1) from costal margin to iliac fossa left side; (2) sausage shaped above umbilicus and separate from the other. On deep inspiration firm mass felt coming down beneath left costal margin	Thin, pale, child. Condition thought to be tuberculous peritonitis.	Child died as preparations for laparotomy were being made owing to signs of general peritonitis supervening, 15/4/21	Not noted in post-mortem report	Death, 15/4/21 F.M. General peritonitis. Ileo-caecal intussusception reaching up per part rectum, irreducible, perforation sigmoid wall ileum projecting (Figs. 2 and 3). Portion of tumor between two masses felt during life was under left costal margin. Section of apex showed round celled infiltration, of mesenteric gland—chronic inflammation.
6	1½	M. Mr. Barrington Ward	5 weeks	Attacks abdominal pain persisting to date of admission	Green and watery. Abated on restricted diet	Opened three to eight times daily. Normal brown motion on admission	Mucus in stools. Blood once	Felt by doctor two weeks ago. On admission 26/7/21. Sausage shaped five inches long transversely above umbilicus. Right iliac fossa empty	Restless, slept badly. Lost weight	26/7/21. Ileo-caeco colic variety. apex half way along transverse colon. Reduced. Bowel oedematous, peritoneal coat damaged	Not noted in case report	March, 1928*. "Seems very well, no return former symptoms."

* Mother's report, March, 1925.

† Included in Mr. Waugh's series of mobile colon. *Brit. Med. Journ.*, 1922, vol. ii, p. 1016.

TABLE I.—Continued
Table of Cases.

Case	Age	Sex	Surgeon	Duration	Colic	Vomiting	Bowels	Blood and mucus	Tumor	General	Operation	Mobility of colon	Result
7	8/12	M.	Mr. Twistington Higgins	3 weeks	Sudden onset with screaming, drawing up of legs and vomiting one hour after drink of "apple water." Ill four days, then recurrence for two days, another attack two days later	At onset and during attacks	Constipated at first; diarrhoea later. Green diarrhoea since last attack	Day following onset passed large quantity blood in motion, also after second attack but never since	Not noted in case report	Extremely ill on admission 23/8/21, T. 103. P. ?	23/8/21. Apex half-way down descending colon. Burst on attempting reduction. Re-section twelve inches ileum and colon to end descending part. Paul's tubes tied in ends	Not noted in case report or post-mortem notes	Death in two hours. P.M. Ends of bowel healthy. Hemorrhages into mucous coat lower twelve inches ileum. Tumor not reported on.
8	8 2/12	M.	Mr. Waugh	2 weeks	Onset sudden, pain which doubled him up. Attacks since with remissions	At onset and occasionally since	Diarrhoea at first, not since normal motions in Hospital and on 20/6/22 enema gave good results when tumor detected	Absent	Mother noticed "lump" below and to left of navel during height of pain. On admission 14/6/22, tender nesses over transverse colon. Examination under anesthetic 18/6/22, negative, 20/6/22, slight fulness ascending and transverse colon	Well nourished	Diagnosed colitis and discharged well 17/6/22. Re-admitted same day, recurrence of colic 23/6/22. Laparotomy. Free fluid, caput cæci variety, reduced; appendix hard and cartilaginous at base. removed. (Section—chronic inflammation. No evidence sarcoma)	Not noted in case report	Discharged well 4/8/22, mother reported that on 8/8/22 sudden onset terrible abdominal pain. Sent to another hospital next day, died same evening from general peritonitis.
9†	2 yrs.	F.	Mr. Fairbank	3 weeks	Gradual onset, attacks of colic during whooping cough, in between, child returned to play. At first colic three times a day. Progressively more frequent and accompanied by screaming	Not at first, frequent later	Confined at first, opened by purgatives. Diarrhoea later	Night before admission passed half pint bright blood, repeated next day	Mother noticed "lump" near navel lately during attacks of pain. On admission 12/2/23, Easily felt in left hypochondriac region	Treated for colic before admission. Miserable wasted child	12/2/23. Ileocaecal variety easily reduced. Tumor at apex? growth? rodoma ileocaecal valve. Given benefit of doubt, abdomen closed	Very mobile colon	March, 1925.* "Very well, no recurrence of former symptoms."

† This case was included in Mr. George M. Gray's series, Lancet, 1925, vol. i, p. 71.

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of an intussusception, and the factor producing obstruction, are dependent upon structural variations in the mesenteries of the large bowel.

This paper is based on nine cases of chronic intussusception occurring amongst 117 cases of intussusception of all kinds admitted to the surgical wards of the Hospital for Sick Children, Great Ormond Street, London, during the years 1919-23 inclusive, together with cases gleaned from the literature to illustrate and emphasize the points raised. I wish to try and show how these cases may be sooner recognized and the irreducible or permanent stage avoided. We must diagnose these cases as simply "intussusception." That is, the invagination of one portion of bowel into another, apart from any considerations of signs and symptoms of intestinal obstruction or the passage of blood and mucus. It will be shown that these are very often late symptoms which herald the onset of the permanent condition even if it has not already taken place; and are entirely dependent upon structural variations in the mesenteries of the large bowel. They cannot be relied upon as diagnostic signs of the presence of an intussusception in its early and curable stage.

The reducible chronic intussusception merges with the recurrent type. Many of the ordinary acute cases give a history of one or more similar, but milder, previous attacks to the present one, which have got well spontaneously. This property of spontaneous reduction and recurrence is entirely dependent upon structural variations of the mesenteries of the alimentary tract, as was pointed out by Waugh⁶ in 1911. Because reduction may have occurred before a doctor has had a chance of examining the abdomen, the real nature of the attack, which will have subsided *pari passu*, is obscured. Herein lies the danger which ultimately ends in the hopeless condition of "permanent" intussusception, and points the necessity of always looking out for simply "intussusception" as a possible explanation of the child's symptoms. At the next attack the doctor may not consider it necessary to examine the abdomen again, in fact, the parents may not even consider it necessary to send for him, and so the condition goes on until symptoms of intussusception with damage to the structure of the intestinal wall supervene.

I wish to emphasize that these cases of "permanent" intussusception do not develop intestinal obstruction except as a late event; they do not die from intestinal obstruction, but from bursting of the intussusception leading to a fatal general peritonitis (Cases 3 and 5). The stage of permanent intussusception is dangerous in the highest degree and in the majority of cases is inevitably fatal; because, as the term indicates, the invagination of the bowel is permanent in that it cannot be reduced at operation or at post-mortem, and because resection of bowel is very often incompatible with life either immediately or remotely, on account of the large amount of bowel involved in most of the cases. Thus Fagge,⁷ in a published series of eighteen cases of intussusception, included two of the chronic variety; one in a child aged nine and one-half years was irreducible, resection was followed by death in five and one-half hours. Symptoms had been present for nine

weeks. The other child, aged eight months, was ill three weeks, resection with end-to-end anastomosis was followed by death in five hours. Peregrine⁸ published a case of double intussusception in a baby of six months that had been treated for diarrhoea for three weeks, when gangrenous gut was passed. Post-mortem; an intussusception impossible of reduction was found. Waterhouse⁹ had to resect the caecum in a girl of four years, death resulting in thirty hours. One of the cases published by Gaymer-Jones, aged eight months with a month's history, was incompletely reduced; ileo-colostomy was performed and followed by death.

Case 4 in this series was very nearly permanent in that it could not be completely reduced. The entering and ensheathing layers were sewn together and the child recovered. Case 8 was discharged well, but evidently developed an acute recurrence shortly afterwards, which ended fatally with general peritonitis. This case may also be cited as a case of recurrent intussusception that was several times spontaneously reduced. Case 1 also, after a fortnight of abdominal pain, was without symptoms for six weeks, is another one of these recurrent cases, and Case 7 is yet another example. The other cases were all reducible at operation, in spite of long histories.

Unfortunately the mesenteric abnormalities have not been noted in the case reports of all these nine cases, but where this has been done, the degree of mobility of the colon has been marked, notably in Case 2, a colopexy was later performed in this case, and was included in Mr. Waugh's¹⁰ latest series of twenty-two cases of mobile colon in children. Comment must be made on Case 4 where the apex projected from the anus, the writer remembers this case well as presenting a marked mesentery to the ascending colon. In a series of twenty consecutive cases of intussusception of all types occurring at the Great Ormond Street Children's Hospital, Gray¹¹ states that in all except one a mobile ascending colon was demonstrated, in one of his cases the colon was very mobile and this case is of the chronic variety and is included in this series of nine cases (Case 9).

All the six cases who recovered have remained well since (March, 1925) except that Case 2 does not always appear to be quite well, but this was considered at the operation for colopexy to be a severe and aggravated degree of mobility of the colon, and the ultimate prognosis was considered to be poor.

In connection with the assertion that chronic intussusception occurs only in older children, it is interesting to note the age of some of these cases. In this series the youngest was eight months, the eldest eleven years, the average being four years and ten months. Peregrine's case was only six months old. Of Still's four cases occurring in infants the youngest was thirteen months, the eldest three and one-half years. Dun,¹² in a paper read before the Liverpool Medical Institution, recorded ten cases of an average age of five years. One of Fagge's cases already referred to was only eight months old. McAdam Eccles,¹³ in his analysis of cases of intussusception, included one aged three months in which the symptoms had lasted sixteen days, and

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another aged six months with a three weeks' history. The former of these two last cases is of particular interest as being a case of spontaneous cure by separation of gangrenous gut per anum, a protruding gangrenous portion being first partially removed by the surgeon. The latter was an ileo-cæcal intussusception fairly easily reduced, death followed, and an apparently recent ileo-cæcal intussusception was found post-mortem. Numerous other cases can be quoted all showing that this variety of intussusception can occur in quite young children, and even in infants.

It has already been pointed out that the stage of permanent intussusception is usually fatal, but

some remarkable recoveries have been described. Pybus¹⁴ had a case in a girl of four years on whom two operations were performed at an interval of nine months. A gangrenous intussusception was removed at the second operation with recovery. Wilson¹⁵ described a case due to sarcoma of the ileo-cæcal valve which was irreducible, the lower ileum and cæcum were removed, with recovery. This case



FIG. 1.—Irreducible intussusception, showing perforation of outer coat leading to fatal general peritonitis.

gave a month's history before admission, and was not operated upon until three weeks after admission. Bernard Pitts¹⁶ described a case in a boy aged two years and three months, giving a history extending over one and one-half years. An ileo-colic intussusception was found, impossible of reduction. A much thickened and ulcerated intussusception was removed by opening the ascending colon, and the boy recovered.

It is remarkable the number of cases of intussusception of the appendix which are described that run a chronic course. Corner¹⁷ said that by an intussusception of the appendix is meant its invagination into the cæcum which is followed by an invagination of the cæcum into the ascending colon. He said that they run a very chronic course and are impossible of reduction at operation or at post-mortem, and that of seventeen cases recorded, sixteen were in children between two and one-half and nine years of age. Bernard Pitts described a case in which the inverted appendix acted as a polypus causing an ileo-cæcal intussusception. Pendlebury¹⁸ and Waterhouse⁹ each described a case, the specimens of which are in the Museums of St. George's

and Charing Cross Hospitals, respectively. Other cases have been recorded by Greig Smith,¹⁹ Wright and Renshaw,²⁰ and McGraw,² the latter also quotes McKidd²¹ and Chaffy.²²

Symptomatology.—The symptoms and signs of chronic intussusception are often very vague and misleading over a considerable period, and often lead to errors in diagnosis until the condition of permanent intussusception is reached. How then can these cases be prevented from drifting into this condition? Only by a careful study of what an intussusception is and how it reveals itself in the first attack can the condition of permanent intussusception be avoided, and the invagination of the bowel dealt with in the reducible stage. I propose therefore to detail the symptoms and signs as presented by these cases and then discuss which of them may be considered as the basic diagnostic signs.

Colic.—Attacks of abdominal pain of a colicky nature are a constant feature of the disease. The attacks increase in severity and in frequency over a period of weeks or months. The onset is very often sudden and the parents may be able to give the exact day and time of day it occurred (Still). The pain is severe and often of a violent nature. Case 5 started suddenly with an attack of abdominal pain accompanied by diarrhoea. Case 7 started suddenly with screaming, drawing up of the legs and vomiting one hour after being given "apple water" to drink. Case 8 started with sudden abdominal pain which doubled him up.

In other cases the onset is more gradual. Case 9 may be cited as an example, where slight attacks of abdominal pain occurred during whooping cough, after the pain the child would return to her play. Later the attacks became more violent.

I have already referred to McGraw's case in a boy of seven years, who had four months of frightful attacks of abdominal pain of a few hours' duration each, recurring every few days. Pendlebury's case had paroxysmal attacks for eight weeks. Penrose and Kellock²³ described a case in a child of fourteen months who had attacks of abdominal pain for a duration of three weeks, at least one a day, and accompanied by vomiting on three occasions. Schlink²⁴ also recorded a case of two months' duration in a child of seven years, starting suddenly with abdominal pain, vomiting and diarrhoea after eating bananas, and diagnosed as "wind." One case after another may thus be quoted from the literature.

The giving of medicine to open the bowels may precipitate an acute attack, as exemplified in Case 1 of this series, but it is not peculiar to these cases, since it so often has this effect in other abdominal conditions, and only further shows the danger of giving purgatives as a remedy for acute abdominal pain accompanied by vomiting.

Vomiting.—This is a variable symptom, but the patient not infrequently vomits at the onset. In some cases vomiting occurs frequently. It is also of the reflex type, due to irritation of the sympathetic nerve plexuses, and is not of the typical regurgitant vomiting with progressive changes in the

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character of the vomited material of intestinal obstruction until towards the end. Reflex vomiting may be so severe as to threaten the life of the patient (Waugh⁴). In other cases vomiting is only occasional.

Case 5 only vomited two or three times during three months. In Case 6 vomiting was controlled when the diet was restricted. Case 9 did not vomit until later in the course of the disease. One of Fagge's cases, aged nine and one-half years, and thought to be tuberculous peritonitis, had only occasional vomiting over a period of six weeks, until three days before operation, when vomiting was frequent and the child presented the clinical picture of obstruction. His other case, aged eight months, was treated for dysentery, and had no vomiting during a history of three weeks, but severe abdominal pain. Rawes²⁵ published a case of Ewen Stabb's aged three years, which was treated for colic, abdominal pain was at times severe for three months, the bowels were regular with streaks of blood in the motions from time to time, vomiting was frequent for the last six weeks, when a tumor was detected.

Blood and Mucus.—Unlike the acute intussusception, blood may be entirely absent from the stools in these cases. Attention is drawn to this in Goodhart and Still's *Diseases of Children*, and Still made particular note of this in his paper already quoted—that blood may be entirely absent or may occur only once or twice and not more than is seen in the stool of any constipated child. Mucus does not occur any more often and this may also be seen in a constipated stool. In one of the two of Fagge's cases no bleeding occurred over a period of nine weeks, while Dun found blood and mucus on rectal examination in only two out of his ten cases. In the case described by Penrose and Kellock, no blood was seen during an illness of three weeks, the apex of the intussusception reached the descending colon. No blood or mucus were seen in Schlink's case during an illness of two months. In the seven cases occurring in children recorded by Gaymer-Jones, blood and mucus occurred in the stools of two, and shortly before admission in a third, in one case slime only was seen, in another the motions are described as "normal, no blood," while in two others no mention is made of either blood or mucus being present. In McGraw's case a little blood and mucus were found in the motions after an attack of pain; during the intervals the motions were normal. Blood and slime occurred only once during three weeks in Pendlebury's case.

Bleeding occurred in slight amount in Cases 2, 3, 4 and 6, and not at all in Cases 5 and 8. Case 2 bled on the day of admission for the only time over a period of three months. Case 3 had hemorrhage only three times during a history of three and one-half months, and only once was it at all severe. Case 4 had abdominal pains with occasional vomiting for nine weeks, the bowels were costive, three days before admission blood and slime were present and diarrhoea occurred. Case 6 passed three to eight motions a day with mucus, blood was observed only once.

Bleeding, however, may be a marked feature and in considerable amount,

in such cases it is not infrequently accompanied by diarrhoea, and it must be pointed out that both blood and mucus may occur in the stools of infective diarrhoea. Blood was in considerable amount in Case 7, and Case 9 had a considerable hemorrhage the night before admission, and recurring the following day, and this was for the first time during an illness of three weeks.

When bleeding does occur it is either during or immediately following an attack of colic, and is more frequently seen towards the termination of the illness (Cases 1, 2, 4 and 9) and when the symptoms are becoming more severe, which is to be expected, since it heralds the onset of the permanent stage of intussusception, as will presently be discussed.

Condition of the Bowels.—There is no absolute constipation except as a terminal event. The bowels may be irregular, some days constipation, other days diarrhoea, notably in Case 5. Sometimes there is increasing constipation, but the constipation reacts well to purgatives (Cases 3 and 9), but as already pointed out, the use of purgatives is not without danger and may precipitate an acute attack. Diarrhoea not infrequently occurs some time during the course of the disease and then towards the end (Cases 3, 7 and 9) when it may be accompanied by bleeding, as exemplified in Case 9.

Ogilvie²⁰ recorded a case in a child of three years who had been ill with colicky abdominal pain and vomiting for three days, but the motions were normal and contained no blood. A tumor was felt on admission to hospital, and visible peristalsis was present. An enema was given and a well-formed motion was passed containing no blood. No blood was present on the finger on rectal examination. The passage of normal motions and the condition of the child were thought to negative the diagnosis of intussusception. A tumor was easily felt under chloroform, so the abdomen was opened and an ileo-cæcal intussusception reaching to the splenic flexure was found and reduced. There were no inflammatory signs or any evidence of interference with the blood supply of the gut. No mention was made as to the presence of any primitive mesentery to the ascending colon. This child had had a similar attack a year previously, passing off in a day or two without treatment. This case was included in Gaymer-Jones' series already mentioned.

Tumor in the Abdomen.—In no fewer than four cases (Cases 3, 5, 8, 9) of the nine cases of this series, a "lump" was noticed in the abdomen by the mother during attacks of pain. "A lump" was noticed in one of Bernard Pitts' cases, a child aged two years and three months who had had attacks of abdominal pain for one and one-half years, later there was constipation, occasionally diarrhoea, and shortly before admission blood and mucus were passed. In Peregrine's case the mother noticed a "lump" in the baby's belly. A "lump" was noticed in the abdomen during the last three weeks in Schlink's case, and a "lump" was also noticed in the case reported by Rawes.

A tumor was felt clinically in all the cases of this series except in Case 7, where no notes were made on the history sheet as to the child's condition on admission, and in Case 8 a fulness only was noted in the region of the ascending and transverse colon. In Case 6 a tumor was felt by a

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doctor two weeks before admission to hospital. Emptiness of the right iliac fossa, together with the presence of a sausage-shaped tumor lying transversely above the umbilicus was noted in this case on admission to hospital.

Wasting.—The patient loses his appetite and wastes rapidly, particularly noticed in Cases 2, 3, 5, 6 and 9, and as Still points out, this is a marked feature and often causes the parents more anxiety than anything else. Schlink's patient became very emaciated, and wasting was noted in some of the children's cases recorded by Gaymer-Jones.

Urinary Symptoms.—Case three complained of frequency of micturition, but no pain. It is interesting to note that Waugh⁸ described three cases with referred penile pain in which an abnormal mesocolon was found. He considered that the pain was due either to the direct pull of the abnormal mesocolon, bearing the extra weight of an intussusception, on the kidneys, or to the mesocolon dragging on the kidneys and thus rendering them mobile with consequent traction upon their nerves. He suggests that this referred pain can be used to recognize the presence of the abnormal mesentery and a departure from the usual treatment of immediate operation made; in fact, one of his cases recurred a week after operation and was reduced by running sterilized saline into the rectum with the pelvis raised, with the full assurance that the gut wall was not damaged. In one of the cases, in which only one ounce of urine was passed in forty-eight hours, a diagnosis of Dietl's crises had been made on the assumption that the free mobility of the kidneys had caused twisting of their pedicles.

In none of the present series was there any penile pain described, and the case that had the frequency of micturition died from peritonitis due to the bursting of the permanent intussusception; in the absence of a post-mortem examination for an abnormal mesentery, its presence or absence could not be verified.

Discussion.—Only an intimate knowledge of the essential signs and symptoms of an intussusception in the first attack, added to a knowledge of how other non-pathognomonic symptoms may be modified by mesenteric variations, will prevent these cases drifting into a hopeless condition. What are the essential signs and symptoms—the basic diagnostic signs? Intermittent



FIG. 2.—Irreducible intussusception reaching upper part of the rectum. Perforation, with small intestine protruding.

colicky pain and tumor formation are the basic diagnostic signs. All others can then be explained as associated or secondary troubles that in the ordinary course of events have many other origins. Their modifications can often be explained by variations in the structure of the alimentary tract, and to such an extent is this true, that the modification of the symptoms may be used to diagnose the presence of the variation in the structure of the alimentary tract before the abdomen has been opened.

From a study of the history of these cases the presence of blood and mucus and symptoms and signs of obstruction are seen to be entirely unreliable as diagnostic features. If these symptoms be present, they are certainly of diagnostic help, but are indications rather than the condition is tending towards the dangerous stage, if it has not already reached it. Many misconceptions have been woven around the description of intussusception, *i.e.*, passage of blood and mucus, symptoms and signs of obstruction, and even the presence of acetonæmia, which is not of the slightest diagnostic importance. Case after case shows that blood and mucus may be entirely absent, or only occur towards the end. The bowels may be irregular, but are not obstructed. The passage of blood and mucus, together with diarrhoea and colic without signs of obstruction, have led to the diagnosis of colitis (Case 8), and one of Fagge's cases was treated for dysentery for three weeks. The presence of normal motions without blood and mucus seemed to negative intussusception in Ogilvie's case, and attention must be drawn to McGraw's case again, in which, although blood and mucus were present during attacks of pain, the absence of obstruction negated intussusception. Waugh⁶ recalls a case in which an ileo-cæcal intussusception was hanging between the knees of the patient without obstruction having occurred. Vomiting may be severe, yet is not of the obstructive type, and it may be only occasional.

The mere invagination of one portion of bowel into another is not *per se* sufficient to produce intestinal obstruction. Congestion and inflammatory œdema are the factors producing obstruction and the passage of blood and mucus, and these tissue changes are brought about by interference with the blood supply of the gut wall. Ulceration and gangrene and the gluing together of the opposed peritoneal surfaces are the end results of these tissue changes, and bring about the irreducible permanent intussusception.

The presence of a primitive mesentery to the colon will enable the head of the intussusception to travel far without obstruction occurring, since the mesentery can pay out as the apex advances without unduly occluding the vessels. Delépine²⁷ said that the absence of laceration of the peritoneum in a case of intussusception, in which the cæcum and appendix had passed from the right to the left side of the abdomen, seemed to indicate that the ascending colon and cæcum must have had a distinct and rather long mesentery. Bernard Pitts described a case in an infant of one year and eight months in which he expected reduction to be difficult on account of a fortnight's history, but it proved to be easier of reduction than the other cases he was describing. There was a very lax mesocæcum. Waugh⁴ has seen

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the intussusception hanging between the knees of the patient in three cases in which a primitive mesentery was present. In two of the cases a cystic tumor of the wall of the small intestine was present at the ileo-cæcal angle. Tanner²⁸ has described a case of acute colic intussusception that was reducible after seventy-four hours. The pelvic colon was elongated, and there was a complete mesentery to the ascending colon. McGraw's case had a mesentery of enormous length to the ascending colon. Mention must also be made of a case of superimposition of a retrograde intussusception upon a direct cæco-colic intussusception recorded by Buckley²⁹ in a male child aged two years. He was admitted very ill with obstruction, after having been ailing five or six weeks, but the length of history and absence of blood in the stools were thought to be against intussusception, while a firm rounded abdominal mass felt was thought to be enlarged mesenteric glands. After difficulty, owing to the complicated nature of the intussusception, it was reduced, when it was found that "the cæcum, ascending, transverse and descending colon had a well-marked, broad and continuous mesentery, so that after reduction it was possible to place, without undue tension, the cæcum in any part of the abdominal cavity." The inflammatory changes both at the apex of the direct intussusception and between the opposed peritoneal surfaces were only slight.

Moreover, some of these cases are spontaneously reduced and reform several times. Waugh has described them, and Bernard Pitts' case already mentioned was a case in point, the intussusception protruded per anum, and this portion was reduced, the child was then inverted, and the abdomen kneaded, when the tumor disappeared with a gurgling sensation, to recur some two or three weeks later, when it was submitted to operation. A case recorded by C. Handfield Jones³⁰ is also of interest in this respect. A boy aged five years had been ill for six weeks with paroxysms of abdominal pain and loose motions, later there were vomiting and signs of obstruction with blood-stained mucus in the stools. He was in hospital eight weeks before operation, a firm mass was felt in the left iliac fossa. During the period in hospital the intussusception was reduced upwards of six times by inflation, and once it was spontaneously reduced. A double intussusception was finally reduced with very great difficulty at operation, the child died nine and three-quarters hours later. Post-mortem there was a very lax mesocæcum, the cæcum was in the primitive undescended condition above and to the right of the umbilicus, and could easily be drawn over to the left iliac fossa.

Perrin and Lindsay's³¹ statistics based on 400 cases of intussusception show that enteric intussusceptions have a relatively longer history before coming to operation than those of the other types, and they base this on the milder symptoms leading to the condition remaining longer unrecognized. They further point out the difficulty in feeling a tumor in enteric intussusceptions, only in eight out of twenty-seven cases of enteric intussusceptions was a tumor felt, while in the colic variety a tumor was felt in fourteen out of nineteen cases. Now I venture to suggest that a possible explanation

is that it is the long mesentery of the ileum that is the factor in causing the symptoms to be milder and not characteristic of acute intussusception. It can pay out to a considerable extent before causing interference with the vascular supply of the gut. Also the clinical sign of a tumor often being absent may be due to the invagination having become spontaneously reduced. One would imagine that the ileum with its long mesentery could readily lend itself to recurrent intussusception; it is, however, very rare. Barrington Ward³² recently recorded a remarkable case in a girl aged six years due to a simple adenopapilloma with symptoms going over a period of three years.

When on the subject of mesenteries, mention must be made of Fitzwilliam's³³ paper on the *Pathology and Etiology of Intussusception from the Study of 1000 Cases*. He has shown that, when only a small amount of mesentery is available, it is impossible for a very extensive invagination to take place, where the mesentery is ample, several feet may be included. He does not consider that the appearance of the head of the intussusception at the anus necessarily implies a mesentery of any extraordinary length, that the increase in length is quite easily accounted for by the extremely lax manner of the attachment of the posterior parietal peritoneum to the abdominal wall in young infants. He maintains that the increase in length is due to borrowing from the parietal peritoneum, that the length of mesentery required to reach the anus never exists normally. He points out that, with a very little traction, the ascending colon, with no mesentery worthy of the name, can be made to stand away from the posterior abdominal wall to the extent of two or more inches. This, however, is contrary to the experience of most surgeons when operating for the removal of an appendix in a patient with a colon and cæcum with no persistent mesentery. Considerable difficulty may be experienced in bringing up the base of the appendix to the surface of the wound, because traction to a degree compatible with safety does not dislodge the fixed colon from its posterior attachment; and the object is generally attained by the applied force stretching the wall of the large gut. In fact the evidence that parietal peritoneum can be pulled out is entirely inconclusive; if this could happen with any frequency then intussusceptions should be able to protect themselves by this means and damage to the gut wall should be avoided *in all cases*. In children with persistent mesenteries to the ascending colon it can be demonstrated quite easily at operation that the cæcum can be placed upon the left side of the floor of the pelvis. This is quite impossible in the absence of such a mesentery. In fact the variations in position, in the rate of travelling from the starting point, and the pathological changes in the gut wall are easily comprehended when the variations in the presence or absence of a congenital mesentery are taken into account: they cease to be so in the light of the theory that any intussusception can pull out the parietal peritoneum into pseudo-mesentery.

I think sufficient has been said to show that paroxysmal attacks of abdominal pain and tumor formation are the basic diagnostic signs, and that the modification of the other classical signs of intussusception are due to

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variations in the structure of the alimentary tract, and are not to be relied upon if an early diagnosis of simply "intussusception" is to be made. Now what are the characteristics of this tumor? They have been described by various writers, and I think they can be best illustrated by discussing a not infrequent error in diagnosis made in these cases—that of tuberculous peritonitis. The palpation of a sausage-shaped mass with obscure abdominal symptoms, irregularity of the bowels, and marked wasting, render this quite an easy mistake to make.

Cases 3 and 5 were diagnosed as tuberculous peritonitis, the former was considered to be so even when the abdomen was opened, since the intussusception was rolled up in omentum exactly simulating a tuberculous mass. In one of Bernard Pitts' cases tuberculosis actually complicated intussusception—mesentery and omentum were adherent to a mass of caseous glands and the upper part of the abdomen was shut off, so that it was thought that this condition might have caused the symptoms; but on searching for the cæcum it could not be found, and on separating omental adhesions an intussusception in the transverse colon was discovered.



FIG. 3.—Section of intussusception shown in Fig. 2. Glass rod placed in perforation.

The tumor may even be nodular at one end; in two of Still's cases this was shown at operation to be due to a bunched-up mass of glands, appendix and mesentery. Three of his cases, and he believes the fourth also, were diagnosed as tuberculous peritonitis by one or other of those who saw them. The case reported by C. Handfield Jones was at first thought to be tuberculosis of the intestines and peritoneum on account of the abdominal pain and the cachectic appearance of the child. Two doctors had previously diagnosed pleurisy and typhoid. One of Fagge's cases already mentioned was diagnosed tuberculous peritonitis; there was a history of nine weeks, three of which were spent in hospital. Pybus reported a case, already referred to, which was diagnosed as tuberculosis of the bowels by a physician. In the case reported by Rawes a lump felt under chloroform was thought to be enlarged mesenteric glands.

Now in tuberculous peritonitis vomiting is rare. The tumor in simple intussusception varies in consistence under palpation, it becomes hard and rigid during an attack of pain, it may alter in size, and it may alter its position. Waugh stated that the tumor varies in size at frequent intervals and eventually disappears entirely as the attack subsides. In Waterhouses'

case the tumor disappeared suddenly under palpation. During attacks of pain in permanent intussusception the tumor does not increase in size, and the precise diagnosis can only be suspected from previous experience rather than from any pathognomonic features of the case. Still drew attention to the varying consistence of the tumor under palpation, which is altogether absent in the tuberculous mass. In the refractory child, he points out, it may be palpated during sleep by passing the warmed hand under the bedclothes if sufficient gentleness be used, thus obviating the necessity for an anæsthetic. Eve³⁴ recommends thorough bimanual examination in the detection of a tumor. Since the bowel may be spontaneously reduced, every opportunity should be taken in suspicious cases to detect a tumor during recurrent attacks, and because one's examination is negative at one time, not to think it not worth while examining the abdomen again. A recurrent intussusception can only be precisely recognized as such after it has been once reduced by operation. These recurrences have been actually witnessed in the wards of Great Ormond Street Children's Hospital. Its tendency may be conjectured by a history of similar attacks culminating in the final one necessitating operation.

Bernard Pitts, Penrose and Kellock, Wright and Renshaw, and Barrington Ward, described these characteristics of the tumor in their cases, while Waugh has pointed out that in tuberculosis of the cæcum the tumor is fixed, does not vary in size, and the discharge of blood is profuse, unlike the small quantities seen in cases of intussusception, and vomiting is as a rule absent.

In connection with a tumor, emptiness of the right iliac fossa (Dance's sign) may be noted, and this when detected is a valuable diagnostic point, but Still draws attention to the danger of imagining this if one is particularly looking for it, therefore care is required in attaching weight to it. The tumor is usually situated transversely across the abdomen above the umbilicus, but its position, however, as distinguishing it from the tuberculous mass, is not of much moment. It may be beneath the liver or costal margin (see Case 5), when an anæsthetic may render it palpable. It may be on the left side, or confined to the right. In the case reported by Eve the tumor resembled a mass in the right iliac fossa due to appendicitis, definite tenderness and resistance were felt in this region. In enteric intussusception the long axis of the tumor lies obliquely athwart the abdominal cavity. (Waugh.)

Visible peristalsis, seen in some of these cases, is not of diagnostic value, it merely shows the presence of obstruction which may be due to other causes, tuberculous peritonitis for instance. When it occurs the condition is progressing to the permanent and hopeless condition. (See Case 3 in which visible peristalsis was noted.)

The character of the stools and the wasted condition of the patients have given rise to the diagnosis of typhoid. (Eve and C. Handfield Jones.)

X-ray examination with an opaque meal was used in one of Still's cases, but was of no diagnostic help, but Schlink's case was finally confirmed as an

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intussusception by this means. It had been variously diagnosed as malignant disease of the sigmoid, sarcoma of the kidney, hydronephrosis, enlarged retroperitoneal glands, and malignant ovary.

There can be no doubt that violent abdominal pain should be looked upon with a surgical bias. It is a truism that violent abdominal pain, followed by nausea and then by vomiting, is a surgical condition, unless true diarrhoea sets in within a short time of the onset. To ignore that warning is to maintain the supply of "too-late" surgical cases of many kinds, in addition to intussusception.

CONCLUSIONS

Is there such a thing as "chronic" intussusception when it is reducible? For how long has the tumor been noted to be present in these cases? Is it not rather a recurrent intussusception in which an attack has brought it under the notice of the surgeon within a short time of onset? In fact, is it not an ordinary intussusception that can look after itself and form and reform many times without any damage to the gut and its functions? Is the term a sound one, and does not its retention obscure the problem and tend to make the medical man think of other things instead of just "intussusception"? Are not all intussusceptions "acute" with common diagnostic features, but varying in degree according to alterations in the structure of the wall of the gut? Is not chronic intussusception in reality a "permanent" intussusception representing the sum total of the undiagnosed previous attacks of intussusception, whereby a transitory tumor has become a permanent one, and the recognition of its real nature may be so delayed that the life of the patient is lost?

I wish to thank the Surgeons of the Hospital for Sick Children, Great Ormond Street, for their kind permission to publish these cases, and I am increasingly indebted to Mr. Waugh for many kindnesses and suggestions, and for much helpful criticism in the preparation of this paper.

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DIVERTICULOSIS OF THE DESCENDING COLON

A REVIEW OF SEVEN CASES

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IN A recent review (Harbin, *Surg., Gyn. and Obs.*, February, 1925) of 500 consecutive laparotomies selected for the study of errors of diagnosis from a series of 1050 of miscellaneous abdominal operations there were 309 acute conditions of which 3 proceeded from diverticulitis of the colon. So practically 1 per cent. of acute abdomens may be expected to arise from diverticulosis of the colon.

The incidence of acute surgical conditions in the abdomen is comparatively rare on the left side and diverticulosis of the descending colon is not so infrequent as generally supposed and should receive due consideration as a diagnostic possibility in this class of cases. Of course, left-sided pelvic infections in the female by becoming attached to the sigmoid play an important rôle in the development of left-sided pathologies, but a careful taken history of these cases serves to differentiate this condition.

Diverticulosis of the descending colon is a non-neoplastic pouch that has been recognized for many years, but its surgical importance has to a certain extent been overlooked. When we consider the colon with its convoluted contour and laxity of attachments subject to inflation and deflation in the presence of foreign bodies and hardened faeces, it is not surprising that these pouches develop through a process of herniation of the mucosa through an attenuated musculature of the colon. It seems probable that small diverticula are more liable to incarcerate foreign particles and infection than larger pouches and when obstruction becomes complete these small abscesses either drain back into the colon or else break into larger subsequent abscesses and may finally set up a diffuse peritonitis. This being true, it is easy to understand that a surgical condition arises by gradations, the fulminating type of peritonitis being the exception. Ischio-rectal abscesses probably form in the same way without invading the peritoneum. We have records of a case of a girl critically studied who refused operation that lingered from this condition three months before death. While the lower peritoneal cavity can better resist infection than the upper, the degree of virulence of infective contents of the colon is greater than that of any other section of the alimentary canal.

Diagnosis.—We have never been able to demonstrate with X-ray but one case of the quiet type of diverticulosis and that in a woman twenty-seven years of age who had been subjected to all sorts of treatment for supposed ulceration of the rectum. Leaving off treatment has seemed to cure her for these four years. The barium enema can only demonstrate a diverticulum when its lumen is patent and therefore symptomless. Furthermore sacculated

portions of the sigmoid may retain portions of the barium for a number of days, thus confusing the diagnosis of diverticulosis.

In the beginning of the acute type symptoms may be primarily negligible or intermittent, evidences of diffuse peritonitis being the exception. The conditions to be differentiated are: Incomplete obstruction of the colon from carcinoma, burrowing perinephric abscess, psoas abscess, prostatic abscess, high ischio-rectal abscess, tubo-ovarian abscesses pasted on the sigmoid, left tubal pregnancy, etc. Careful history taking with abdominal, rectal and vaginal palpation are our most valuable means for diagnosis. Operative diagnosis can be made by exclusion and the contents of the abscess are extremely fetid, showing fecal contamination.

Prognosis.—Among the more extensive statistics the operative mortality is given at 70 per cent. or more, but this excessive rate is in our opinion due to radical surgery that attempts to reveal every phase of pathology, resorting finally to resection. Conservative surgery seems to offer better immediate results and in our experience is equally curative from follow-up reports.

The symptoms are those of a local peritonitis usually without vomiting that creates more or less obstruction and brings about pressure on contiguous organs. In suspicious cases it is well to bear in mind the menace of using enemata.

CASE I.—(No. 2789, November 27, 1921.) Male, age sixty, college president, was examined four months previously and diagnosed as a case of acute pyelitis, having had hypertension for a number of years. Two weeks ago he began to suffer with left lower abdominal pain and entering hospital a definite induration was palpable, with a temperature of 102. Barium enema showed displacement of sigmoid to the midline, leucocyte count being 13,600. Pre-operative diagnosis undetermined. Through a left gridiron incision the abscess was drained. Convalescence was normal but on the fifteenth day had symptoms of pulmonary embolism from which he died twelve hours later.

CASE II.—(No. 4903, October 14, 1923.) Woman, age thirty-three, multipara, had definite left pelvic soreness for ten days with chills and temperature of 100° F. and retraction of left thigh. Left induration palpable by abdomen and vagina. Leucocyte count 21,000 and urinalysis negative. Pre-operative diagnosis of diverticulitis was made. Abscess containing fetid pus was drained through a left rectus incision. After an active septic record she was discharged from the hospital on the eighteenth day. Two and a half years later she reported a cure.

CASE III.—(No. 4969, November 16, 1923.) Male, age thirty-five, truckman, being an ambulatory case was examined for left-sided soreness which had existed fourteen days with some rise of temperature and rigidity of abdominal muscles. There was no urinary distress and leucocyte count was 19,600. Induration was palpable high in the pelvis and barium enema showed sigmoid displaced to middle line. A diagnosis of diverticulitis was made and operation advised, and after five days he acquiesced. An abscess with characteristic contents was drained through a left rectus incision and was dismissed from hospital on eighteenth day. One year later he reports a cure.

CASE IV.—(No. 5793, February 29, 1924.) Woman, age forty-five, multipara, gave history of four or five attacks of lower abdominal pain in bed. A similar attack began about two weeks ago with intermitting periods of improvement and had not had bowel movement in five days, with occasional vomiting. There was marked tympany with tense vaginal vault, leucocyte count being 20,200. A provisional diagnosis of acute obstruction from carcinoma of the colon was made. Through a left rectus incision an abscess was

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revealed burrowing down into pelvis. Convalescence was tedious and she was discharged from hospital on the thirty-sixth day. A reply from her two years later reported a cure.

CASE V.—(No. 6312, June 12, 1925.) Man, age twenty-nine, weighing 258 pounds, gave a history of diarrhoea lasting three or four days one year ago. Otherwise the previous history was negative. Four days ago he suffered pain from lifting. Purgatives were ineffective. Bladder was catheterized for diagnosis with negative result. Pain with dysuria persisted without vomiting and leucocyte count on second day was 9500, temperature 101-102 and pulse 100. Rectal palpation was negative. A provisional diagnosis of perforated diverticulitis was made but on account of obesity it was decided by two consultants to defer operation in the hope of a mistaken diagnosis, all of which having been explained to the family. On the fourth day vomiting of dark fluid began and abdomen was opened and revealed a diffuse peritonitis fluid from the sigmoid being apparent. He died thirty hours later and autopsy verified the above findings.

CASE VI.—(No. 6457, August 13, 1925.) Woman, age thirty, multipara, gave history of laparotomy for tumor three years ago. She has had pain in abdomen two weeks with increasing soreness in left pelvis with a palpable induration. The uterus seemed to be somewhat fixed. Urinalysis was negative and leucocyte count was 9500. X-ray revealed sigmoid reduplicated. Pre-operative diagnosis of diverticulitis of sigmoid was recorded. Through a left rectus incision the abscess was drained and she was discharged on eighteenth day. A follow-up inquiry has not been answered.

CASE VII.—(No. 6887, March 3, 1926.) Boy, age seventeen, gave history of left-sided abdominal pain with occasional vomiting for ten days. The seriousness of his condition was not discerned by his family. Present examination showed a mass in left abdomen. His temperature was 101° F., pulse 120 and leucocyte count 42,400. Provisional diagnosis of diverticulitis was made and laparotomy through a low right rectus incision revealed a large abscess containing fecal fluid. He died from exhaustion on twelfth day after operation.

Conclusions.—Our statistics show in the acute abdomen the incidence of 1 per cent. of diverticulitis of the descending colon.

2. Acute pathologies in the left abdomen should suggest the probability of a diverticulitis of the colon.

3. Small pouches because of easier obstruction would seem more prone to the development of acute surgical conditions.

4. The symptoms are usually those of local peritonitis, the fulminating type being the exception (Case V).

5. The X-ray cannot demonstrate these pouches so long as the lumen remains obstructed as in the acute type.

6. Conservative surgery in our hands gives a mortality of 30 per cent. and uniform cures, while radical methods in larger statistics give a mortality rate of over 70 per cent.

7. In this series the oldest was sixty and youngest seventeen and average age was thirty-five.

8. The longest duration before operation was fourteen, shortest four and average eleven days and average length of stay in hospital was twenty-two days.

9. The provisional diagnosis corresponded to the final diagnosis in five cases and there were two surgical deaths, or a mortality of 30 per cent.

FORTIFYING THE TRIANGLE IN REPAIR OF INGUINAL HERNIA*

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THIS is not another new operation for the cure of inguinal hernia, it is just a plea for the use of two additional sutures which should help to eliminate tension in repair of hernia in that region.

The inguinal triangle has been described as that part of the lower abdomi-

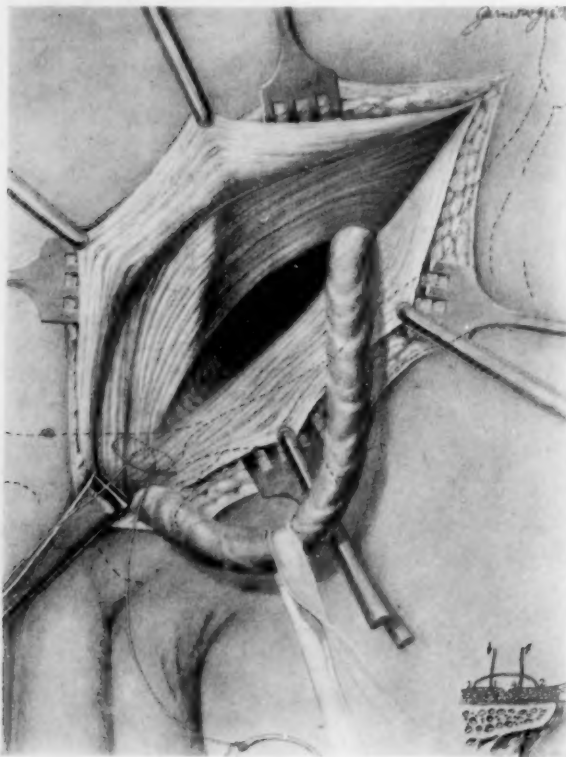


FIG. 1.

nal wall bounded below and on the outer side by Poupart's ligament, internally by the edge of the rectus muscles and above by a horizontal line extending from the anterior superior spine to the rectus muscle.

It is an established fact that almost any type of operation is satisfactory for inguinal hernia in children, and the same applies to the average indirect hernia in adults under thirty-five, provided the sac is completely eradicated. There is, however, a certain percentage of indirect inguinal herniæ that are not average, and in some instances recurrence may appear in the form of a direct hernia if

all available measures are not utilized to eliminate tension on sutures applied in that part of the inguinal triangle immediately below the deep epigastric artery. This is the commonest seat of recurrence of direct hernia and the point where deficient musculature should always be reinforced to withstand intra-abdominal pressure.

The approximation of tissues without suture tension at the time of opera-

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tion is an essential factor in repair of hernia, and of equal importance is the maintenance of approximation during sudden vomiting or coughing spells which may occur in the first ten days of post-operative healing. It is questionable if there is any surgical operation more gratifying when successful, and none is more perplexing than those followed by the recurrence of hernia, all of which should emphasize the fact that even in what appears to be the simplest form of inguinal hernia, no step that will minimize suture tension and prevent recurrence should be overlooked.

To recommend the reduction of tension in sutures directly concerned in repair of the weakest point in the inguinal triangle, by the use of sutures indirectly concerned and inserted at the apex of or below the inguinal triangle, is paradoxical to say the least. As the production of tension anywhere is contrary to surgical principles, it may not be out of place to mention, at this point, that such sutures are inserted over bony structures and in region that plays no immediate part in repair, and that the only possible effect of tension at this distant point is a replacement fibrosis which should have no influence on repair.

Operation.—The inguinal canal is exposed by the usual incision which is prolonged downward slightly to permit free exposure of the lower attachment of Poupart's ligament and the conjoined tendon in front of the pubic bone. The aponeurosis of the external oblique having been divided, both flaps are retracted. The fibres of the cremaster are separated and the cord is lifted from its bed as in the Bassini operation, and the lowest suture passes through the lower limit of the insertion of Poupart's ligament, the conjoined tendon and edge of rectus if necessary, as shown in Fig. 1. The second suture is passed in a similar manner but higher, as shown in Figs. 2 and 3. Both sutures are inserted directly in front of the pubic bone but not immediately above as practiced by Coley and others in completing the usual Bassini

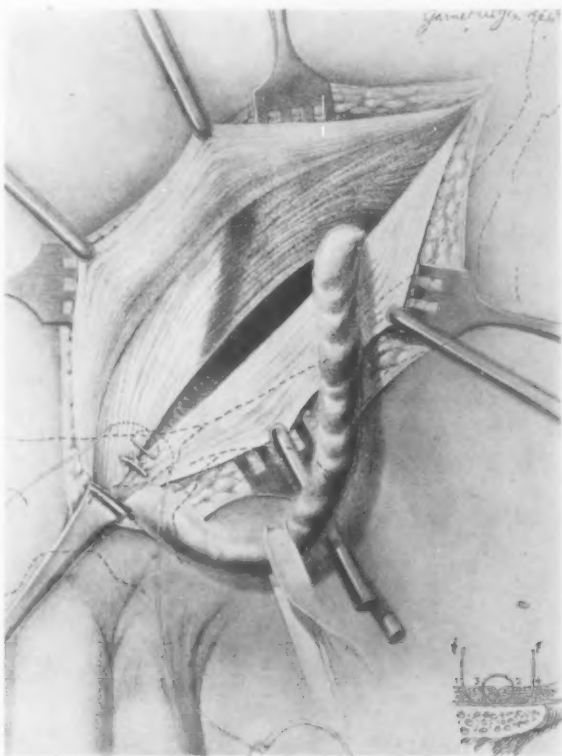


FIG. 2.

operation. Both sutures are tied sufficiently tightly to straighten out the arching fibres, thus permitting easy approximation of tissues without undue tension when the final sutures are applied in the inguinal triangle, especially in the area between the deep epigastric artery and the pubic bone, which is the weak point in direct hernia.

At this stage any of the recognized radical operations can begin and be

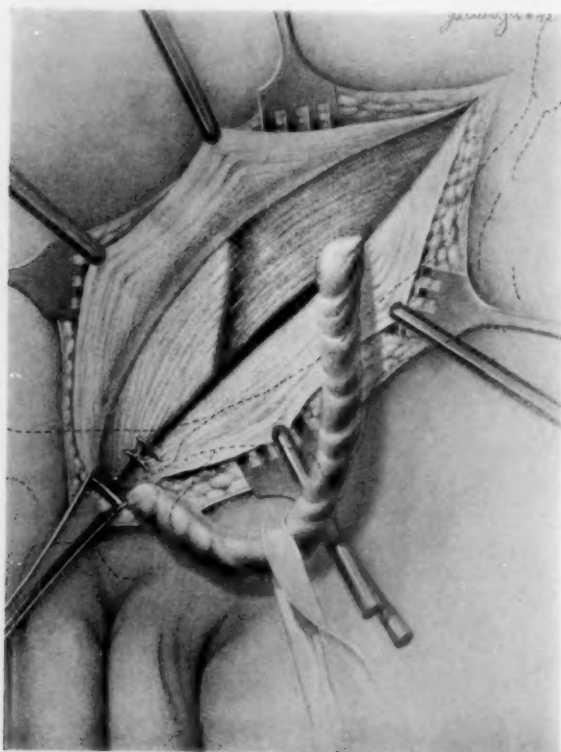


FIG. 3.

carried out in the usual manner, with far less suture tension and more support of the inguinal triangle.

From 1901 to 1907 the author used the Bassini operation, plus a single suture in front of the pubic bone, which included a lesser amount of the tissues than shown in illustrations, with very complete excision of the sac, and the results were satisfactory.

In 1907, after becoming a convert to the views of the great master Halsted, he abandoned the Bassini and transplantation of the cord, and during the period between 1907 and 1919 the Halsted or Fergusson procedure was

followed. During this period some surgeons laid great stress on the dangers of injury to the bladder in removal of the very small type of sac in direct hernia, and in a few instances small sacs were not removed.

From 1907 to 1919 the percentage of recurrences was greater than during the period in which the Bassini operation was used. This was especially evident during the Mexican border mobilization where the author had an opportunity to observe eighty-nine cases which had been operated by this method. Many of these were seen for nearly a year under service conditions. Again in 1919 he used, for a time, a no transplantation operation which was a modified Fergusson, with somewhat similar results, but the method was abandoned for the Mayo modification of the Bassini, with very complete eradication of the sac and tension sutures as described. From 1919 to date, of the eleven hundred and some odd herniæ operated at the Walter Reed

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General Hospital, eight hundred and fifty-five were inguinal. The remainder were of irregular types which do not belong in this group.

The percentage of recurrences is so small that for the purpose of accuracy it is deemed wiser to defer recording them until more time has elapsed and records are sufficiently complete for a future paper which will include the percentage of indirect, direct and recurrent inguinal herniæ.

As to what factors influenced the changes in results it is not possible to state accurately, as satisfactory results were obtained in the original Bassini with high ligation of the sac and transplantation of the cord and the one tension suture in front of the pubic bone. In this connection we cannot overlook the deductions of Lameris' relative complete obliteration of the sac.

Comment.—1. These tension sutures have been found advantageous in all inguinal herniæ to insure support of the inguinal triangle and prevent recurrence by helping to eliminate tension and in certain types of direct herniæ where the conjoint tendon is not obliterated to too great a degree but is somewhat deficient. The medial insertion of the sutures shown in Figs. 1, 2, and 3, frequently includes more of the rectus muscles than shown. It changes the plane of the rectus close to its origin sufficiently to permit its aiding in support of the lower part of the inguinal triangle, and in this changed position it is not easily detached by the straight-line pull of the normally functioning rectus muscle, while the opposite is true when the sheath has been split and the fibres of the rectus sutured to Poupart's ligament with a result that the pull is changed from one in a straight line to an obtuse angle pull with its resulting detachment of the rectus fibres when functioning normally.

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GLUTEAL ANEURISM

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OF CHARLESTON, S. C.

THE occurrence of gluteal aneurism is rare enough to merit reporting instances of its occurrence. In a search of the available literature comparatively few of this variety of aneurism were found. There were five hundred and fifty-one aneurisms in Crisp's³ collection and in this number only five were of the internal iliac, making less than one per cent. of all aneurisms in his collection. Hence the occurrence of gluteal aneurism is a much smaller per cent. Rupp⁹ (*Inaug. Dissert.*, Königsberg, in 1907) collected forty-five cases of aneurisms of the gluteal artery. In five years from 1916 to 1921 only five new cases of gluteal aneurism have been reported. At the Mayo Clinic for eleven years there were twenty-one patients reported by Ott⁸ who were suffering with aneurism and in only one was the internal iliac ligated. Since 1921 to date only two cases have been published, my own case and one of J. E. Benjamin.² This last case was one of mycotic aneurism of the gluteal artery, unoperated and which died two months after admission into the hospital.

Haggard,⁶ in his excellent article in the *ANNALS OF SURGERY*, October, 1922, says that for the most part gluteal aneurisms are traumatic from direct or indirect violence; however, no history may be obtained of injury and they are described as spontaneous. Matas,⁷ in *Keen's Surgery*, states that out of twenty-eight cases of this class of aneurism twelve were due to wounds and twelve to ruptures or lacerations caused by fracture of the pelvis or contusions, falls on the buttocks, etc. Goldammer⁵ reported a case of gluteal aneurism that developed shortly after patient had been beaten on the buttock with a board. According to Matas⁷ "the gluteal artery is more frequently injured by direct wounds (stabs), the sciatic by falls on the ischium or buttocks which fractures the pelvis or tears the artery at its exit from the sacro-sciatic foramen." In Rupp's collection of forty-five gluteal aneurisms, thirty of these were of the traumatic variety. This type of aneurism seems to be about equally divided as regards the sexes. Although Haggard⁶ states that "the vast majority occur in men and are most frequent between the twentieth and fortieth years." I have found that among five cases before me three of these occurred in women. The size of the aneurism varies between a small lemon to the size of a very large grapefruit.

A preliminary ligation of the internal iliac should always precede the operation on the aneurism itself. The wisdom of this operation can hardly be overstated and yet Frost,⁴ in his case of a large traumatic gluteal aneurism, neglected to do this until after he had made his buttock incision thinking that he could control the hemorrhage without tying the internal iliac. When the fascia of the buttock was incised "there was a sudden spurt of arterial blood

GLUTEAL ANEURISM

rising upward some four feet." The sac was promptly packed, the patient turned on his back, the abdomen opened and the internal iliac quickly ligated. This saved the life of his patient. However, I do not believe that the ligation of the internal iliac alone will cure the aneurism because the aneurismal sac is being distended with blood not only by the afferent artery (internal iliac in the case of gluteal aneurism), but the sac has also entering into it several vessels from the collateral circulation which, if not ligated or obliterated, will certainly continue to distend the sac and perpetuate the aneurism. Hence, rational and adequate surgery of a gluteal aneurism consists of ligation of the internal iliac artery and at the same sitting the obliteration of the sac and ligation of the other arteries entering the sac.

Adams¹ is of the same opinion and in the report of his case of gluteal aneurism comes to the following conclusions: "Aneurism of the gluteal artery should be treated by: 1. Preliminary ligation of the internal iliac; this in itself is harmless and will control hemorrhage from sac. 2. If a well-formed sac is present then oblitative endo-aneurismorrhaphy is the ideal method."

The ligation of the internal iliac does not cause gangrene of the extremity, and does not seem to compromise the vitality of the leg in any way. This is due to the fact that there is a free anastomosis of its branches and a copious collateral circulation. This collateral circulation is maintained chiefly by the anastomosis of the uterine and ovarian arteries, hemorrhoidal branches and those from the inferior mesenteric, of the circumflex and perforating branches of the profunda femoris with the sciatic, of the gluteal with the posterior branches of the sacral arteries.

CASE REPORT.—A negro woman, forty-five years of age, was admitted into the Roper Hospital on August 4, 1924, occupation washerwoman. Chief complaints were a swelling on the left buttock and severe pain down the left thigh and leg. Health always good, having had no serious illness or injury. About three years ago, she had an eruption on the thighs, chest and genitals for which she did not receive any treatment. She has been pregnant fifteen times, first eight children born living, the last seven pregnancies were either still births or miscarriages. Her last pregnancy was three years ago. She has had the usual infectious diseases of childhood.

About three months ago she first noticed a small swelling on the left buttock which has rapidly increased in size so that to-day it is as large as a large sized grapefruit. During this time she has experienced a pulsating or throbbing pain continuously in this location. This pain is so intense at times that she was finally compelled to seek relief. The pain and swelling has been so troublesome lately that she has been confined to bed and has been unable to move her left leg. She has never had any swelling or discoloration of her limbs. She gives no history of trauma. Her menstruation is regular and painless, duration three to four days up to three months ago, when duration increased to two or three weeks; flow is rather copious. She has had leucorrhœa at intervals for several years. No pelvic nor abdominal pains complained of.

Physical Examination.—The patient is a fairly well-nourished negro woman about forty-five years of age and weighs about 112 pounds. Her temperature is 98.6° F., pulse 96 and respirations 24, costo-abdominal in character. Blood-pressure 140/95. Her general physical examination is negative except for the condition of her heart and left buttock. The cardiac area was slightly increased and the aortic second sound accentuated. There is a systolic murmur heard best at the apex and transmitted to the left axilla.

DANIEL L. MAGUIRE

There is a large diffuse pulsating swelling of the left buttock about the size of a large grapefruit. The tumor is soft and painless except on deep pressure. There is a distinct thrill and bruit present. The movements of the hip and knee are somewhat painful but apparently these joints are negative.

Laboratory Examinations.—Urinalysis was practically negative revealing only a one plus albumin with no casts. However, on August 13, 1924, the day following the operation, the urine showed a four plus albumin and two plus hyaline and granular casts. She continued with a four plus albumin up to the date of her discharge. Blood—hæmoglobin 45 per cent., erythrocytes 3,869,000, leucocytes 8440, small lymphocytes 29.5 per cent., large lymphocytes 10 per cent., polymorphonuclears 60 per cent., eosinophiles .5 per cent. Wassermann reaction four plus.

A gynæcological consultant was called in to express his opinion as to the possibility of an intra-pelvic aneurism or any pelvic masses which might cause the menorrhagia. He reported the vagina negative, the cervix infected, the uterus somewhat soft and normally anteflexed and somewhat over to her right. The appendages are prolapsed and adherent, old salpingitis. There may be an intramural or submucous fibroid accounting for her menorrhagia or it may be due to the congestion from the aneurism. The pelvis on the left is clear and not encroached upon by any mass. An X-ray examination of the bones in the region of the swelling was negative.

Diagnosis.—Aneurism of the left buttock, probably of the gluteal artery. It was planned to do a preliminary ligation of the internal iliac artery on the left side and then at the same operation an intra-saccular suture of the aneurismal sac wall. This last operation being the obliterative endo-aneurismorrhaphy as described by Matas.

Operation.—August 12, 1924. In moderate Trendelenburg position and through a median incision the left internal iliac artery was recognized and exposed by incising the posterior peritoneum in this location. This artery was dissected free and two ligatures of chromic catgut No. 2 placed around it and securely tied. The posterior peritoneum was sutured over the artery with plain catgut No. 0. The abdomen was closed in the usual way. *Second operation.* (Same time.) The patient was placed partly on the abdomen and the left buttock exposed. A longitudinal incision about eight inches long was made over the mass down to the sac. When this was opened a very copious and at first alarming bleeding ensued. The bleeding was controlled with firm pressure of several hot packs and ligation of the arterial openings in the sac wall. The sac was evacuated of large blood clots and fibrin. It was then obliterated with successive layers of suture with chromic catgut No. 2, fascia sutured with chromic catgut and skin with interrupted silkworm gut.

The patient was returned to the ward in weak condition; pulse 148, of poor quality. She reacted fairly well, however. Her convalescence was uneventful except for a slight infection in the wound of the buttock. On the tenth day, post-operative, the patient developed an œdema of her face and both feet, which on her discharge from the hospital was gradually subsiding. Patient remained in the hospital thirty-five days.

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KIENBOCH'S DISEASE OF THE SEMILUNAR BONE

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A CONDITION of the semilunar bone of the wrist of rare occurrence has recently been described in two important surgical journals in this country.^{1, 2} The semilunar bone is shown in röntgenograms to have undergone a destructive process with fragmentation. Kienboch, who revived interest in this condition in 1910, discussed it from the standpoint of the röntgenologist and considered the lesion as one produced by a momentary, spontaneously reduced luxation, in the course of which there was an avulsion of the dorsal ligaments with tearing of the most important blood-vessels. Following this initial trauma, which may produce an osteitis in this bone, an injury occurs at some later date and of more or less severity and a secondary fragmentation occurs.



FIG. 1.—Antero-posterior view of the injured wrist. Note the decrease in size and outline of the semilunar bone with fragmentation of this bone. The articular surface of the radius appears roughened particularly in the region of the radial styloid where there is evidence of an old healed injury.

The patient presents symptoms of a sprain of the wrist with slight tenderness and swelling over the semilunar bone. The diagnosis is made with the röntgenogram.

The prognosis from the recently published articles is not good. The patients are unable to perform hard work. A few weeks of splinting does not relieve them. Continued discomfort for several years with the wearing of splints for relief may be the outlook of the patient.

The treatment of this condition presents a problem of considerable economic importance. Goldsmith¹ presents three case reports and advised operation in two and was unable to trace the third. Unfortunately for the sake of the solution of this problem his patients refused operation. One of

them was compelled to change her occupation on account of this condition. Henderson² presents two case reports and advised against operation. In Henderson's first case splints were recommended and a prognosis was given of probably continued discomfort for several years. Henderson's second case was also splinted.

When this problem was first presented to the writer the question of removal of the offending bone or a prolonged period of disability at once



FIG. 2.—Lateral and antero-posterior views of the injured wrist six weeks after removal of the semilunar bone. Note the encroachment of the ulna on the carpal space and the absorption of cartilage between the radius and the scaphoid.

presented. The patient was a railway employe who could not afford to take a prolonged rest unless adequately compensated, and as is so often the case, he probably would be compensated. We have removed this bone when dislocated and our patients have returned to work. If the bone is not necessary after dislocation and removal is indicated, the question naturally arises as to the indication of the same treatment if the bone is producing disability from other non-inflammatory causes. After considering the problem in this manner, we decided to remove the fragmented bone and offer the following case report:

A. H., section laborer, male, aged forty-eight years, first consulted the writer December 10, 1924, when he stated that two days previously he was sweeping a switch and he slipped and fell and struck the back of his left wrist against the point of a switch rail. Immediately following this accident he was unable to work because

KIENBOCH'S DISEASE OF THE SEMILUNAR BONE

of pain in the wrist. He denied previous injury to the wrist. (History was obtained through his daughter as an interpreter.)

On examination the left wrist was found to be slightly swollen, more so over palmar aspect of the wrist, and the wrist was tender on pressure. Flexion and extension were greatly limited.

Dr. F. S. Bissell reported on röntgenograms as follows: "Antero-posterior and lateral views were taken of the injured wrist and an antero-posterior view was taken of the normal wrist for comparison. There is evidence of a destructive process and fragmentation of the semilunar bone. A small fragment is displaced forward. The articular surface of the radius appears roughened and partly decalcified.

Conclusions: Chronic osteitis probably secondary to temporary dislocation of the semilunar bone with evidence of recent fracture of this bone."

Operative removal of the bone was advised and he was immediately sent to the hospital for operation. Operation, December 11, 1924, at New Asbury Hospital, ether anæsthesia. A longitudinal incision one and one-half inches long was made over the palmar surface of the left wrist at about the middle of the wrist. The tendon of the flexor carpi radialis was retracted radialward and the remaining flexor tendons were retracted to the ulnar side. A fragment of the semilunar bone lying flush with the anterior lip of the radius was removed. The remaining fragments of the semilunar bone were next removed. When the operation was completed the wrist motions were as good as those of the opposite wrist.

Recovery was uneventful and on December 16, 1924, the patient left the hospital.

January 20, 1925, Dr. R. G. Allison reported on röntgenograms of his wrist as follows: "Antero-posterior and lateral films were made of the left wrist. These show the semilunar bone to have been removed. The ulna is encroaching on the carpal space. There is absorption of cartilage between the radius and the scaphoid.

Conclusions: Removal of the semilunar bone of the left wrist with resulting joint changes which allow the ulna to encroach on the carpal space. This gives a moderate limitation of motion."

January 22, 1925, the wrist motion was roughly measured as follows: Palmar flexion of injured wrist to one hundred sixty-three degrees and dorsal flexion to one hundred thirty-three degrees. Palmar flexion of the normal wrist to one hundred thirty-five degrees and dorsal flexion to one hundred twenty-three degrees. By the same method of measurement the writer's wrist could be flexed to an angle of one hundred fifteen degrees while the patient's daughter was found to have the same amount of flexion at the wrist as the normal wrist of her father. This would suggest a familial tendency to large strong joints with limited motion. On this date steady improvement was noted.

February 10, 1925, two months after injury, he returned to work as a section laborer.

April 20, 1925, palmar flexion had increased to one hundred fifty-three degrees. He was working and his wrist was getting stronger.

March 10, 1926, sixteen months after injury, he had been working long hours through two nights of a snowstorm and reported with a respiratory infection. When questioned about his wrist he stated that his wrist did not hurt and that he had been working steadily for over one year.

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TRANSACTIONS OF THE NEW YORK SURGICAL SOCIETY

Stated Meeting Held April 28, 1926

The President, DR. WALTON MARTIN, in the Chair
NEUROFIBROMA OF CAROTID SHEATH

DR. FRANK MATHEWS showed a patient aged fifty-eight, who had had a tumor on the left side of neck for four years. It pressed the left tonsil far inward and caused difficulty in breathing during sleep. It lay far up under the angle of the jaw. It was removed under rectal anaesthesia and was about the size and shape of a hen's egg, the smaller pole being in contact with the base of the skull and the lower pole occupying the bifurcation of the carotid. It was encapsulated and not difficult of removal. The external and internal carotid occupied grooves in its surface. The hypoglossal nerve ran transversely across the middle of the tumor. The reporter said that he had supposed it a tumor of the carotid body until the pathological report was made. These tumors in the carotid sheath lie high under the angle of the jaw, press the pharyngeal wall inward and may cause hemi-paralysis of the tongue. In a previous case which was presumably a carotid body tumor, the pupil on the affected side was dilated. This patient had a temporary paralysis of the tongue and still has some difficulty with swallowing, probably due to anaesthesia and paralysis of glosso-pharyngeal origin.

TRAUMATIC ANEURISM OF SUBCLAVIAN ARTERY

DOCTOR MATHEWS presented a boy, aged fourteen, who in July, 1919, was shot through the neck just above the right clavicle. Five months later he was operated upon. Paralysis of the right arm had been immediate and continuous. There was stiffness at the elbow, atrophy of the forearm, stiffness of fingers with tendency to claw-hand. There was no total paralysis in the distribution of any nerve and it was inferred that the lesion was in the nerve cords proximal to their formation of the brachial plexus. The aneurism lay immediately above the clavicle. Pain was absent. Operation was undertaken largely with an idea of improving the nerve function. At operation, the clavicle was divided and a careful dissection undertaken in order not to further injure nerves which lay in front of the aneurism. The dissection identified the scalenus margin above the aneurism and the ligation was made behind the muscle in the second portion of the artery. There was no temporary increase of paralysis and the clavicle united firmly. At present function has been completely restored except for slight general weakness of the arm.

FALSE ANEURISM OF BRACHIAL ARTERY

DOCTOR MATHEWS also presented a child, aged three years, who had an abscess in the left axilla which was drained by an incision through the skin. A forceps was inserted through this opening and a counter-incision made through the skin on the back of the arm at the junction of the upper and middle third. The wound bled rather conspicuously at dressings but healed shortly and the patient was discharged. A few days later he returned to the hospital with a pulsating swelling and with a bruit over the mass, heard

CHRONIC DUODENO-JEJUNAL OBSTRUCTION

as far down as the termination of the brachial artery. At operation, a temporary ligature was first placed under the artery above the profunda branch. This only partially controlled bleeding. Careful dissection revealed a false aneurism, bleeding from which was controlled from within the sac by pressure. The surrounding nerves were dissected away without injury to them and a small opening was identified in the artery. A probe was passed up and down and ligatures were applied immediately above and below the opening. Following operation, the wound healed satisfactorily and there was no sign of diminished circulation though the arterial pulse, previously present, disappeared and has not returned.

CHRONIC DUODENO-JEJUNAL OBSTRUCTION

DR. ALFRED S. TAYLOR presented a woman, twenty-nine years of age, whom he first saw in June, 1924.

As a child she had repeated bilious attacks—headache, nausea and vomiting, three or four times a year. Always constipated.

Trouble was more marked from twelve to twenty-one years of age, after which there was marked improvement until she was twenty-five, since which time trouble has gradually grown worse.

During the last few months the attacks have occurred twice a month. During the last two years there has been a loss of 20 pounds in weight. During the last few months there has been disturbance of vision. Examination of the eyes detected well-developed albuminuric retinitis. She was referred to an internist who found constant evidences of nephritis associated with a blood-pressure of 176 to 190.

She is tall, slender, poorly nourished. Urine showed albumin and casts. Abdomen shows diffuse tenderness in right lower quadrant with somewhat greater tenderness half way between right anterior superior spine and umbilicus. Much gas on manipulation, especially in one place just above umbilicus over an area of 5 cm. in diameter. X-ray series showed marked ptosis of stomach, the major part of which was in the true pelvis; very atonic; loop of duodenum very greatly dilated; duodeno-jejunal angle directly in front of the spine, showed evidences of marked obstruction. Marked gastric retention at six hours, also retention in dependent loop of duodenum.

July 10, 1924, operation under ether. Transverse incision through the right rectus just above the umbilicus. Findings: well-marked hepato-duodenal membrane (Harris band). Stomach markedly dilated and ptosed. Pylorus widely dilated. Entire duodenum markedly dilated, especially in the dependent portion. Obstruction of duodeno-jejunal angle. Long, somewhat large appendix.

Procedure: Division of Harris band. Duodeno-jejunal anastomosis. Appendectomy.

Recovery was uneventful and improvement prompt and very marked. By the end of three months there had been complete recovery of health.

There were no abnormal conditions present in the urine. The albuminuric retinitis had entirely cleared up; she had gained in both weight and color and had no disturbing symptoms whatever.

April 28, 1926, almost two years after operation, the eyes were perfectly normal; blood-pressure was 120/88; pulse rate was 80; urine was perfectly normal; abdomen normal to examination.

She has remained perfectly well since operation.

This case is shown to indicate the very marked change in the general health of the patient from correcting the digestive disturbances.

While one does not often see the nephritic complications present in this

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case, in the ordinary chronic duodenal obstruction, nevertheless, it would seem as though the correction of the digestive disturbance had in this particular instance resulted in a very remarkable change in the general metabolism.

HEMILAMINECTOMY FOR SPINAL CORD TUMOR

DR. ALFRED S. TAYLOR presented a woman, aged thirty-six years, who after a negative history up to February, 1913, was confined to bed for six months because of a septic infection. Two months after recovery, *i.e.*, November, 1913, the back of the neck would be temporarily stiff on wakening. January, 1914, pain first appeared between the shoulder-blades and occurred only at night. Relief was obtained by getting up.

The pain became steadily worse for six months and gradually spread to the back and both arms to the elbows.

September, 1915, not quite two years after the onset, weakness developed in the lower extremities, especially on the right side.

December, 1915, twenty-five months after the onset, there developed complete loss of function in the cord at the level of Cervical vii. She then became bedridden. Sphincteric control was also lost.

January 31, 1916, under ether anaesthesia, a right hemilaminectomy was done from Cervical vi to Dorsal ii, inclusive.

A soft, friable, vascular, lobulated tumor 3.5 x 1.5 x 1 cm. was removed from beneath the arachnoid.

There were no adhesions to the cord substance. The tumor extended from Cervical vii to Dorsal ii, inclusive. It lay mostly to the right side of the cord, extending slightly beyond the left midline, dorsally, and forward as far as the level of the anterior roots. It was removed completely with no trauma to the cord.

Recovery was uneventful. On the third day bladder sensation had returned with capacity to hold urine until attention was given. On the sixth day bladder control was completely restored. On the fourteenth day she sat up in a chair for a half hour. On the thirty-fifth day she had a large, formed stool, and from that time on there was control of the bowel.

April 8 she was able to get into and out of bed by herself, and could get about by holding onto chairs, etc.; also had recovered complete use of her hands.

She has made a perfect recovery and now (April, 1926) is perfectly well in every way.

This case is shown particularly to emphasize the occasional value of hemilaminectomy. A tumor of considerable size was removed through the hemilaminectomy and there was no disturbance of the cord resulting from the manipulation.

Inasmuch as several different men doing neurological surgery have reported cases in which dislocation of the cervical spine has occurred following the usual laminectomy, and inasmuch as in one clinic a case has been reported where death occurred from such dislocation of the cervical spine, about six or eight months following operation, it would seem that, particularly in the cervical region, hemilaminectomy has advantages in that the spinous processes and the remaining laminae, together with their muscles and ligaments, add very greatly to the stability of the cervical spine.

DR. CHARLES A. ELSBERG said he strongly believed that in all operations for spinal cord tumor, unless one was very certain that the tumor lay on the

STRICTURE OF RIGHT HEPATIC DUCT

posterior surface of the cord, a wide laminectomy should be done so as to give the minimum amount of manipulation to the cord. But in what Doctor Taylor had said as to the presence of tumor in the cervical region in young people, he agreed with him that hemilaminectomy is advisable at first, complete laminectomy to follow if necessary.

DOCTOR TAYLOR rejoined that as hemilaminectomy in the cervical region had come to be viewed favorably, he believed it would win its way for other regions by and by. He recently did a hemilaminectomy at Bellevue in the mid-dorsal region. Going in on the right side the tumor, $\frac{3}{4}$ cm. in diameter, was revealed in front of the dura, was removed, and the man had made a good recovery. One of the points of advantage in hemilaminectomy is that if one can locate the side on which the tumor is situated, one can get a better anterior exposure without undue manipulation of the cord than with the usual laminectomy. Another point of advantage is that if one has made a mistake in estimating the size or situation of the tumor, by doing a hemilaminectomy one can find out the actual condition and then do as much of a bilateral laminectomy as is needed. The speaker said he had done this several times. This procedure of hemilaminectomy was worked out at a time when the localization of spinal cord tumors was not as perfect as it has become in the last ten years.

STRICTURE OF RIGHT HEPATIC DUCT FOLLOWING CHOLECYSTECTOMY

DR. CHAS. GORDON HEYD presented a woman, aged forty-four years, who entered the New York Post-Graduate Hospital, January 5, 1926, complaining of persistent jaundice, sharp colicky pains in the right upper quadrant, nausea and vomiting, and tenderness in the area of a previous right-sided upper abdominal incision. The woman stated that in February, 1925, a cholecystectomy was performed at another hospital, following which she was in the hospital for four months, with a continuous biliary discharge and with an approximate loss of weight of fifty pounds. When her physician referred the case to Doctor Heyd, he stated that the cholecystectomy was performed for cholelithiasis and involved no difficulties. During the patient's convalescence in the hospital, her abdominal wound closed and reopened a number of times, and eventually at the end of four months the abdominal wound was entirely closed and she was discharged. At this time the patient thought that she was jaundiced but was not quite sure. The woman was first seen by the reporter December 16, 1925, at which time she was markedly jaundiced, and on physical examination presented a mass beneath the right lobe of the liver. The clinical diagnosis at this time was chronic obstructive jaundice from extraductal pressure, or possibly an injury to the external biliary bile ducts. The patient entered the New York Post-Graduate Medical School and Hospital January 5. The pre-operative study showed a negative Wassermann: A leucocytosis of 11,800, polynuclear of 61 per cent. The urine showed a faint trace of albumin, 0.30 per cent. of sugar, negative for diacetic acid and acetone: microscopically four to five white blood-cells per field. The icterus index was 9.3, quantitative van den Bergh 0.62 mg. per 100 c.c.; Fouchet positive. Chemical blood, non-protein nitrogen 100.0, uric acid 2.7, urea nitrogen 11.9, amino acid N 6.4, sugar 0.082, cholesterol 0.167, carbon dioxide combining power 41.9, fibrin 0.501. Bleeding time four

minutes; clotting time four minutes. Red cells 3,240,000, tendency to microcytosis and variations in color.

January 9, 1926, the abdomen was opened through a right upper rectus incision. The liver showed a moderate degree of fibrosis. The hepatic flexure and duodenum were firmly united to the under surface of the liver as a result of an intensive proliferating chronic peritonitis. The stomach was hypervascularized and adherent to the under surface of the former upper abdominal incision. At the midpoint of the pyloric ring was a perforating ulcer with a defect 3 cm. in diameter. This was adequately occluded by apposition to the under surface of the liver. At the point of fixation of the ulcer, the duodenum was angulated upon itself, backward and to the right, and firmly adherent to the under surface of the liver along its superior border. The hepatic flexure was also firmly united to the under surface of the liver. At the site of what would be the cystic duct was a thick, hard, indurative mass traversed by the remnant of the right hepatic duct. Apparently the right hepatic duct was the site of an occlusive inflammation. There were some adhesions between the omentum and the anterior abdominal wall. The omental adhesions were separated. The pylorus was identified and brought out of the wound and the duodenum separated throughout its entire extent from the under surface of the liver. During this procedure the perforating ulcer was exposed. Following which a Horsley pyloroplastic operation was performed with excision of the ulcer margin. This procedure resulted in an infolding of considerable gastric tissue. The ideal procedure would have been to excise the ulcer and close the defect in the pylorus and do a gastro-enterostomy, but in order to save extra surgical manipulations it seemed wise to excise the ulcer and do a pyloroplastic operation. The hepatic flexure was separated from the under surface of the liver and the common duct identified by means of an hypodermic syringe and the aspiration of bile. After identification of inferior portion of common duct a clean knife dissection was carried out, exposing the common duct *in toto*. At what would apparently be the scar of the cystic duct the common duct passed into a hard ridge of inflammatory tissue. Just below this ridge the common duct was opened and attempts made to probe from below upward. These were unavailing and the right hepatic duct was identified above the scar by means of the aspiration of bile. A longitudinal incision was made through the scar tissue and carried down to the common duct. The hepatic duct was dilated and a No. 10 French rubber catheter inserted therein. The catheter was carried down well into the common duct. The gap between the right hepatic and common ducts was then sutured in a transverse direction, the incision connecting the two ducts having been in a longitudinal direction. The result was the creation of an ample lumen between the hepatic duct and the main channel of the common duct. A cigarette drain was inserted into Morrison's space and two sheets of rubber tissue were inserted between liver and duodenum, and a single sheet of rubber tissue was carried down to the suture line around the catheter in the hepatic duct. The abdomen was closed in the usual anatomical fashion with a subcutaneous drain of rubber tissue.

The post-operative course was uneventful, except for the fact that the patient tended to the development of a slight alkalosis on the third day after operation, as evidenced by the carbon dioxide combining power 71.1. Drainage was removed on the ninth day, and the patient was discharged from the hospital on the fourteenth day after operation. The follow-up note, April 21, 1926, "a normal abdominal wound; patient has gained thirty pounds in weight and is entirely free from any local or general complaint."

Comment: It is probable that the cystic duct in this case originated from

ACUTE CATARRHAL JAUNDICE

the right hepatic duct and that during the cholecystectomy the hepatic duct was partially divided. The origin of the perforated duodenal ulcer subsequent to operation was probably due to local inflammatory conditions that arose subsequent to the cholecystectomy.

ACUTE CATARRHAL JAUNDICE—LOCAL NECROSIS OF LIVER

DOCTOR HEYD also presented a woman, aged forty years, who entered the New York Post-Graduate Hospital, February 25, 1925, complaining of pain in the right upper quadrant, and a progressively increasing jaundice of one month's duration. About one month previous to admission to the hospital, while on the street, she had a chill, and upon returning to her home noticed a rash on her right forearm. This eruption spread over her entire body and disappeared in two days, at which time she began to have pain in her arms, legs, and fingers, with swelling of these parts. "The hand was so swollen she could not make a fist of the fingers." At the end of a week the swelling had disappeared and the pain had changed to "a sensation like needles over all of her body." About a week later patient began to have pain in the epigastrium on the right side under her ribs. This pain became so severe at times that she could hardly bear it. At the time the patient complained of severe colicky pain her stools became white, and jaundice appeared. During this period vomited only twice and always after eating meat. The patient is a well-nourished, middle-aged woman, intensely jaundiced. The right pupil is somewhat smaller than the left and both react to light and accommodation. On abdominal examination the liver is easily palpated, six cm. below the costal margin in the nipple line; tenderness is marked, with considerable spasm on inspiration. Remainder of physical examination is not noteworthy. The clinical diagnosis at that time was that of catarrhal jaundice, although a luetic hepatitis was considered. During the patient's stay in the hospital the jaundice became progressively more intense and deep and the patient began to develop stupor tending to coma. The Wassermann was always negative. The coagulation time was seven minutes. The bleeding time was ten minutes, and the blood grouping showed group two. An examination of the urine revealed a moderate amount of albumin, 0.30 per cent. sugar, and was negative for diacetic acid and acetone. Microscopically a few white cells and amorphous urates. Previous to operation the blood analyses were as follows:

Date	N—P—N	Urea N	Amino Acid N	Choles- terol	Fibrin	Icterus index	van den Bergh		Dye test	
			Mg. per 100 c.c.				direct	indirect	15 min.	60 min.
2/27/25	31.9	8.3	7.2	160	340	225	++++	++++	15	20
3/2/25						220	++++	++++		

In view of the patient's increasing jaundice and the development of stupor, the clinical diagnosis was changed and a provisional diagnosis was made of chronic cholemia due to possible malignancy, extrinsic occlusion of common duct. An intravenous injection of 10 c.c. of four per cent. calcium chloride was given and an exploratory laparotomy decided upon. March 4, an exploratory laparotomy was performed. The liver was about one-third larger than normal, with apparently normal edges, although there was some slight evidence of an interstitial hepatitis. The liver generally suggested a biliary stasis and was otherwise not noteworthy. The gall-bladder was about twice its apparently normal size, but not markedly distended. The pancreas

appeared normal on palpation. No calculi were to be determined in the common duct nor any apparent mass within the pancreas. The stomach and duodenum were negative.

The absence of any demonstrable pathology to account for her jaundice, except possibly the rather distended gall-bladder, caused much doubt as to whether any further operative procedure should be carried out. It was not apparent that biliary drainage would help her, and it was evident that the loss of bile through an external fistula was not a desirable thing, yet no bile was being delivered into the intestine. In the desire to allow the bile to enter the gastro-intestinal tract and the possibility of a small overlooked calculi in the ampulla of Vater, a cholecystogastrostomy was performed and at the same time a small section of the right lobe of liver was removed for histological examination. It is interesting to note that following the cholecystogastrostomy for forty-eight hours her jaundice became more intense, for on March 6, a note by Doctor Donaldson stated that the jaundice was more intense, although the patient felt much better. The blood analyses following her operation are particularly interesting as showing the gradual clearing up of the jaundice:

Date	N—P—N	Urea N	Amino	Choles-	Fibrin	Icterus Index	ven den Bergh		Dye test	
			Acid N	terol			direct	indirect	15 min.	60 min.
			Mg. per 100 c.c.							
3/10/25	33.0	13.7	6.5			80	++	++	7.5	10
3/18/25	22.4	7.5	7.0	166	340	52	++	++	0	4
3/26/25						15	—	+		
4/29/25	30.0	12.5				10	—	+	5	0

The small portion of the gall-bladder removed in making the cholecystogastrostomy ostium on histological examination showed no evidence of any pathological change. The pathological report on the liver tissue showed the lobular structure was easily recognizable. The Glisson's capsule was thin and several lobules near this surface as well as in the deeper areas showed changes within the centre of the lobules. The changes were characterized by the disappearance of liver cells to such an extent that the centre of the lobules showed only the framework without liver cells. In these areas of the liver lobules there was a proliferation of the endothelial cells and numerous lymphocytes and occasional polymorphonuclear leucocytes were to be seen. The liver cells, particularly near the centres, which were preserved showed parenchymatous degeneration occasionally with karyolysis. There was only a small amount of bile pigment recognizable in the cells. The picture was that of a central necrosis of the liver lobules. It could be compared to the changes of acute yellow atrophy, only it was of a much milder degree. The gall-bladder showed regular rugæ. The gall-bladder wall was devoid of pathological changes.

Epicritical comment: This case aroused the interest of both the laboratory and clinical sides of the service and repeated study and consideration finally convinced them that her first manifestation of trouble was an acute febrile condition simulating acute articular rheumatism, and from this she sustained an intense and progressive injury to the hepatic parenchyma, resulting in a picture of severe central necrosis of the liver lobules. While the slides do not show the outstanding features of acute yellow atrophy, they do suggest the same picture, only of much milder degree. After the intoxication had

TUBERCULOSIS VERRUCOSA CUTIS OF THE ELBOW

passed its critical point there was a normal regeneration of liver tissue, so that the patient has remained permanently well. It is interesting to note that she has had no discomfort from the presence of a cholecystogastrostomy and at the present time the patient is in the fifth month of a pregnancy. He believed that this patient's liver is functionally competent and that she should withstand the additional hepatic labor of a pregnancy without any ill effects.

TUBERCULOSIS VERRUCOSA CUTIS OF THE ELBOW

DR. CLARENCE A. McWILLIAMS presented a man, thirty years of age, who is a cutter on ladies' hats. He previously had had a healed lung tuber-

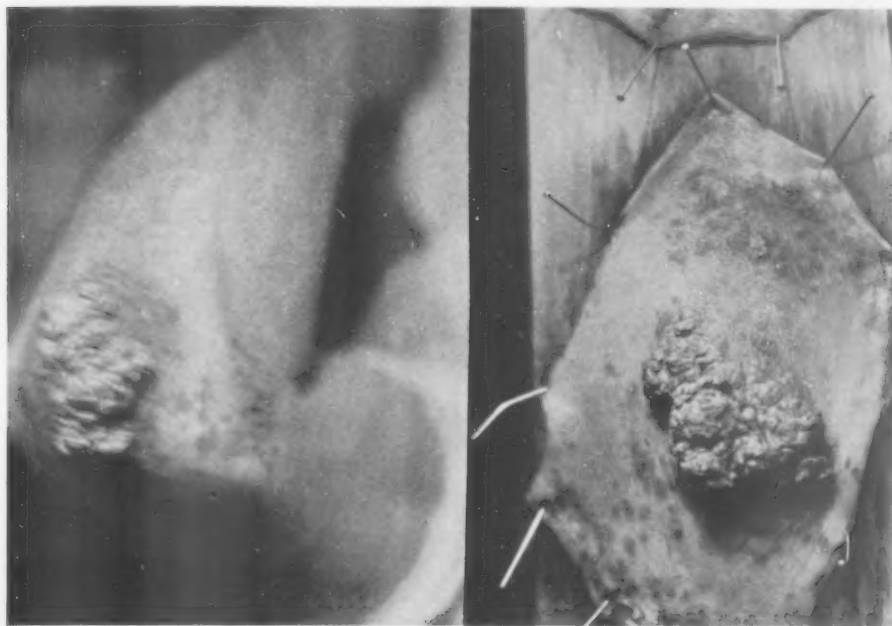


FIG. 1.—Tuberculosis verrucosa cutis of elbow cured by full-thickness free graft.

culosis. For the past three years he has had a warty, polypoid tumor on the back of the right elbow, which stands out half-an-inch from its base, two inches long and one inch wide. Around this tumor for three inches transversely and the same vertically, the skin is peppered with red spots the size of buckshot. There was no ulceration present. There was a similar small area on the mid-outer side of the right thigh. He was operated upon on January 21, 1926, by a quadrilateral incision over the back of the right elbow, removing a section $3\frac{1}{2}$ inches wide and 3 inches vertical, including tumor and affected skin, extending down to deep fascia. This area was decreased by about half-an-inch in all diameters, by deeply passed silkworm gut, mattress sutures, armed with rubber tube guards, to prevent cutting of the sutures. A pattern was cut out of rubber tissue of exactly the same size (no larger) as that of the defect, and this was laid on the abdomen, and a piece of full-thickness skin was excised, from which all the attached fat was removed from the graft with knife, not scissors, so as not to close the capillaries of the graft by pinching. This was sewn into place by closely placed, interrupted, fine silk sutures. The lesion of the thigh was removed and its edges completely closed by sutures without grafting. A sterilized rubber bath sponge, moistened with

salt solution, was bandaged smoothly and firmly over the elbow graft and the arm was immobilized in full extension on a board splint. First dressing was on the fifth day. There were areas of superficial necroses in small spots on the surface of the graft, and it did not look promising; but I have noticed this same occurrence in large sized, full-thickness grafts numerous times. The necrosis may not extend through all the depth of the graft and, as in this instance, the epithelium has completely regenerated itself. What is particularly noticeable is the movability of the graft on the deeper parts. I

attribute this to the regeneration of the fine connective-tissue strands left on the under surface of the graft.

Flexion and extension of the elbow are perfect. This elbow situation certainly is a most severe test for a free graft, being a curved surface on a flexure about a joint. A Thiersch graft would be out of the question because of the subsequent contraction which would result. Probably what most surgeons would have done would be to reflect a pedicled flap from the chest. This was what I would do finally had the full-thickness graft failed.

On the elbow, in this situation, there is very little fat under the skin, so a free, full-thickness graft, which is without fat, is much more appropriate to the location, if it succeeds, than a pedicled flap which always must have fat on it. This fat frequently, after having healed *in situ*, must be trimmed out so as to decrease the prominence of the transplanted flap.

The last uncertain element in making free, full-thickness grafts has been removed by Ferris Smith, who reported, in the April number of *Surgery, Gynecology and Obstetrics*, that he had experimentally proved that 30 mm. of pressure was just the right amount to be applied. This he does by an inflatable rubber ballon. With this accurate method of applying pressure, we now may expect our house surgeons to have as much success with free, full-thickness grafts as with Thiersch grafts. The advantages of free, full-thickness grafts over abdominal pedicled flaps are obvious; the comfort of the patient is so much greater, not having the arm immobilized to the side for fourteen days; there is only one operative procedure as against at least two, and frequently three, in pedicled flaps, and finally the time required to complete pedicled flaps is at least double that with free, full-thickness grafts.



FIG. 2.—Result of free full-thickness skin graft for tuberculosis verrucosa cutis of elbow.

DANGERS INCIDENT TO CHOLECYSTECTOMY

BRODIE'S ABSCESS OF OS CALCIS

DR. CLARENCE A. MCWILLIAMS presented a young man, who consulted him the last of December, 1925, on account of severe pains in the right os calcis for three weeks, typical of bone involvement, without any etiological factor. It was so bad at night that he could not sleep and he had to keep his foot out from under the bed clothes. By day the pain was relieved by walking. There was no temperature nor external, local evidences of inflammation, though over one spot on the mid-back part of the right os calcis, there seemed to be more than normal tenderness. X-ray made the diagnosis: In the centre of the mid-back part of the right os calcis there was an oval, quarter-sized shadow with clear-cut edges; around this the bone seemed only slightly sclerosed. In addition, there was a marked spur on the under surface of the right os calcis which certainly had no connection with the abscess and which had never caused any symptoms.

Ether was administered December 31, 1925; a transverse incision was made over the centre of shadow, the bone was exposed, and, with chisel, an opening was made directly into the cavity from which creamy pus was evacuated. Culture was sterile from the pus. The cavity was packed and a small wisp of the gauze was brought out at one spot, the rest of the wound being sutured.

The reporter remarked that he had not brought himself to follow Doctor Brickner's suggestion to sew up these cavities completely after evacuating the pus, though it would probably make no great difference whether one did or not, except in the time of convalescence in some few cases. Those wounds which are sterile would probably heal per primam and those which were not, would break through the sewed skin. This wound, notwithstanding that the culture was sterile, has not healed yet, though it is almost four months since the operation. Up to within a week ago the discharge was purulent, but now it is clear, following the expulsion of two small, bony granules. Evidently bone necrosis has taken place in the walls of the cavity.

For two months he had not been draining it, but had injected the sinus with Beck's bismuth paste once a week. There has been no pain nor discomfort in the foot since the cavity was opened, and he has been very active in the gymnasium and hand-ball courts.

DANGERS INCIDENT TO CHOLECYSTECTOMY

DR. HENRY W. CAVE read a paper with the above title, for which see page 371.

BRIEF COMMUNICATIONS

SIMULTANEOUS SEPARATE ANEURISM OF THE COMMON ILIAC ARTERIES

THE present case, Mrs. L. M'P., is seventy-six years old. She entered Jamaica Hospital, March 29, 1926 and died April 3, 1926. She was first seen and referred by Dr. M. A. Bender of Jamaica who referred her for surgical care. This patient gives a family history of tuberculosis and cardio-vascular disease. Besides the common childhood diseases and occasional coryzas, Mrs. M'P. declares she has been in good health up to two years ago. At this time she contracted pneumonia, was ill five weeks, but was able to resume active life thereafter. For an indefinite period she was aware of an increasing size of her abdomen but believed it to be due to an innocent tumor that demanded no special medical attention. On March 29, 1926 she was taken severely ill with excruciating pain in the central abdomen and vomiting. Pain radiated into the dorso-lumbar region of back. Pain continued without relief from morphia for three hours and patient was considerably shocked upon admission to hospital.

Temperature ranged from 98 to 101 only reaching 104 shortly before death. Pulse ranged from 70 to 130 and respirations from 20 to 30. Physical examination was negative excepting for the local condition. In the lower left quadrant of the abdomen is an irregular, hard, cystic tumor filling this section of the abdomen and bulging into the vault of the vagina. The mass is fixed posteriorly while the abdominal wall moves freely, over it. Distinct ballottement is obtained through the mass with one hand on the abdomen and one in the vagina. The urine showed a slight amount of albumin and hyaline casts. The blood count was 20,000 and 91 polymorphonuclears. The blood pressure in both radials was 128 systolic and 70 diastolic on the 30th. Wassermann performed on blood after death was negative.

The tentative diagnosis upon admission was intra-abdominal hemorrhage possibly within an ovarian cyst. The findings at operation under gas-oxygen ether were a large tense, lobulated, retroperitoneal tumor containing recently clotted blood and retroperitoneal fat and a dilated pulsating aorta and iliac vessels. The expansile pulsation more distinctly felt in the lumbo-sacral region made the diagnosis of aneurism. The aneurism extended from the intercrestal line to the true pelvis and occupied the left half of the posterior wall of the abdomen. The other abdominal organs were negative but displaced by the aneurismal tumor and retroperitoneal blood. A cigarette drain was left inside a small incision in the retroperitoneum, the accessible clotted blood was lifted out, and the wound was closed.

Morphia and hypodermoclyses were administered. The patient reacted from operation and did astonishingly well until the fifth day when, with no ominous changes in the pulse or respiration, she suddenly collapsed.

The operative findings were confirmed by an incomplete necropsy performed upon the abdomen by Drs. E. J. Buxbaum and G. Stohr who further report as follows:

"Extensive meteorism of the entire gut. The intestinal loops are covered and fused by organized fibrinous exudate, loose blood and blood clots are present in the abdominal cavity. The posterior peritoneum is ruptured over the top of a large hemorrhagic tumor which occupies the entire left and partly the right retroperitoneal cavity and which is partly adherent to the neighboring abdominal wall and to the underlying tissues. In attempting to free these tissues the abdominal aorta was accidentally perforated at the site of the bifurcation and large masses of liquid blood flowed into the abdomen.

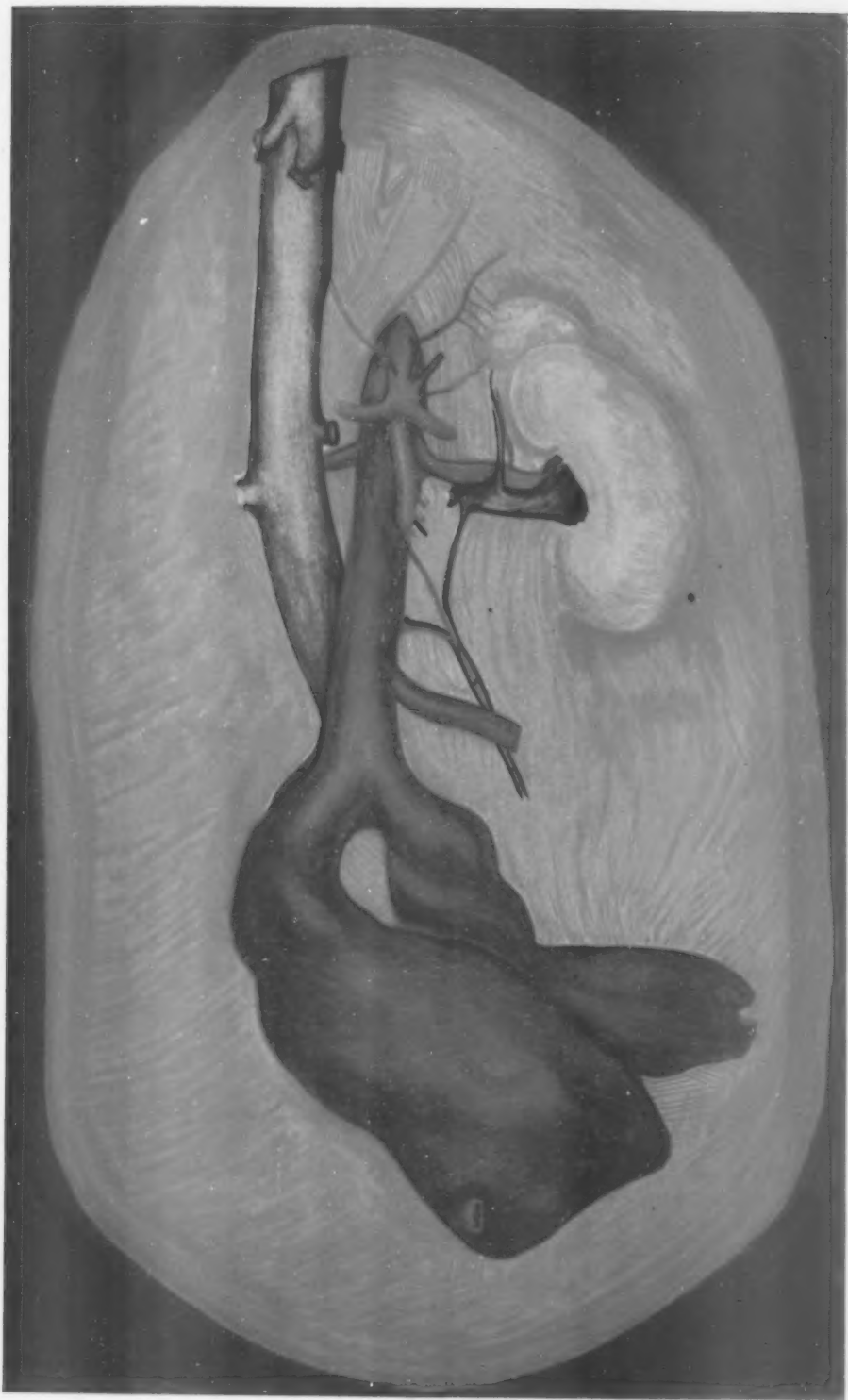


FIG. 1.—Aneurism of both common iliac arteries. Note distortion and change in direction. Rupture had occurred five days ante-mortem at the lower end of the right common iliac sac.

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Upon closer examination the mass was found to be composed of the right and left common iliac arteries which are so situated that the right common iliac superimposes the left and both are turned in a semicircle to the left side. Both vessels are considerably enlarged and irregularly bulged and present tubular tumors of very solid consistency. The right artery reaches a diameter of five to nine centimetres, the left five centimetres. Both are fixed to the posterior abdominal wall by firm adhesions.

The abdominal aorta, which was severed about three centimetres above the bifurcation, shows pronounced atherosclerosis. The lumen of both common iliac arteries appears filled with a solid, friable, hemorrhagic mass which is intimately attached to the vessel wall.

The microscopic section shows the vessel wall composed of thick laminated cicatricial connective tissue which does not present any specific structure. Internal to this coat are heavy layers of a more loose cellular connective tissue which becomes more cellular and vascular toward the lumen. The lamellae of this region are interrupted by extensive hemorrhages which in some areas comprise the entire inner surface. In other areas endothelial cells are present lining the inner wall over short portions of its surface.

Diagnosis.—*Dissecting aneurism of the right and left common iliac arteries, atherosclerosis of the abdominal aorta, peritonitis exudative.*"

Simultaneous aneurisms of both common iliacs is evidently a very rare occurrence. No case to date appears on our records at Bellevue Hospital. It is noteworthy in this particular case that the patient believed herself to be in good health and was able to continue an active useful life up to five days within her death when rupture occurred. Mass, tenderness, rigidity; sub-normal temperature; a sustained pulse, and a high leucocytosis indicated intra-abdominal hemorrhage. The rupture of the lower end of the right aneurismal sac probably accounted for the absence of expansile pulsation on vaginal examination and the absence of pulsation in the right femoral artery.

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PERFORATION OF A JEJUNAL DIVERTICULUM

Recent case reports and reviews of the literature by Helvestine,¹ Watson,² Mackechnie,³ and Terry and Mugler⁴ have shown the rarity of jejunal diverticula. They collected twenty-seven cases which have previously been reported. In the entire summary, there is no case reported in which acute perforation occurred as a sequence of inflammation. The following case is therefore worthy to be reported:

CASE REPORT.—A male, seventy-five years of age, complaining of severe general abdominal pain, was admitted to the hospital at 2 P.M., June 3, 1925. His past personal history was unimportant with the exception of indefinite upper abdominal discomfort which consisted of pressure and fulness, appearing from two to three hours after meals.

The patient was well during the day of admission until 12.30 P.M. At this time he was seized with violent pain in the epigastrium. The pain was constant, increasing

¹ Helvestine, F.: Surg., Gynec. and Obst., 1923, vol. xxxvii, p. 1.

² Watson, C. M.: Surg., Gynec. and Obst., 1924, vol. xxxviii, pp. 67-71.

³ Mackechnie, H. N.: ANNALS OF SURGERY, 1921, vol. lxxiv, p. 96.

⁴ Terry and Mugler: Arch. Surg., 1921, vol. xi, p. 345.

PERFORATION OF JEJUNAL DIVERTICULUM

in intensity and soon involved the entire abdomen. Vomiting of gastric and duodenal contents followed a few minutes after the onset of the pain.

When admitted his temperature was 100-2/5, pulse 115, respirations 24. He appeared very ill. He lay on his left side with knees flexed. The skin was cool and moist; the pulse was rapid and of low volume and tension. The abdomen was retracted and abdominal respirations were absent. Marked rigidity was present over the entire abdomen, and there was board-like resistance in the epigastrium. The patient was given morphia and 1200 c.c. of saline subcutaneously. His general condition improved and operation was begun two hours after admission to the hospital.

Under gas-oxygen anaesthesia the abdomen was opened. The upper abdomen was



FIG. 1.—Segment of jejunum as resected showing peritoneal surface. Sacculations at mesenteric margin demonstrated, one small pouch involves a portion of mesenteric root. Arrow indicates site of perforation. The walls of this sac were attenuated to thickness of tissue paper.

flooded with a cloudy, greenish-tinged, non-offensive fluid. All peritoneal surfaces were injected. Careful examination of the stomach and duodenum revealed no perforation. A mass was found to the left of the midline and on a level with the umbilicus. This proved to be a loop of jejunum 25 cm. from the ligament of Treitz. The walls were much thicker than normal and in a space of 15 cm., seven diverticula were present. They appeared as sacculations on the mesenteric border and varied in size from 1 to 2.5 cm. in diameter. The two largest were bright red in color and their peritoneal coats were thickened and friable. A perforation 4 mm. in diameter was found in the centre of the largest. (Fig. 1.) Resection, 15 cm. in length, with end-to-end anastomosis was done, together with a Coffey enterostomy 8 cm. below the anastomosis. The catheter end was passed upwards through the anastomosis for 6 cm. The peritoneal fluid was removed with an aspirator, and the abdomen was closed without drainage. The resected intestine consisted of 15 cm. of thickened jejunum; microscopical examination

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proved the diverticula to be of the false type. The stomata leading to the diverticula varied in size from 3 mm. to 1 cm., the largest being that of the one in which perforation had occurred. The mucosal borders of this stoma were red, indurated and friable.

The patient's immediate post-operative condition was good. Subcutaneous salt solution (2500 c.c.) was given daily, and fluids by mouth were withheld. The maximum temperature for the first twenty-four hours was 101, pulse 120, respirations 28. Drainage from the enterostomy totalled 14 ounces; urinary output, 12 ounces. Urea nitrogen, 48.4 mgms. per 100 c.c. During the second twenty-four hours, the temperature and pulse

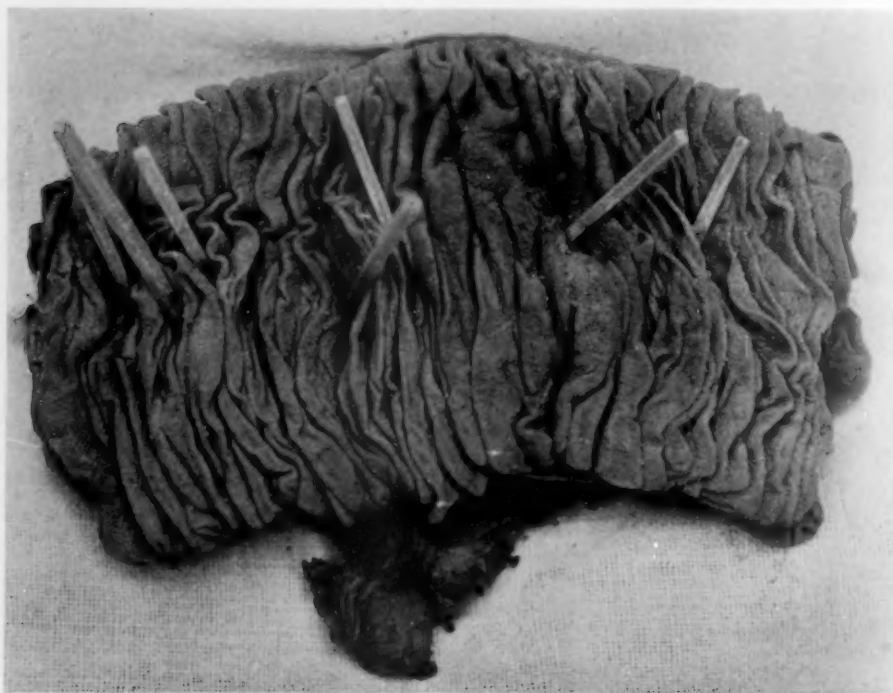


FIG. 2.—View of the mucosal aspect, with match-sticks inserted into the stomata of diverticula.

continued to rise. The abdomen was flat and soft, peristalsis diffuse. Râles appeared throughout the left chest. The urinary output dropped to 8 ounces, and death occurred in seventy-two hours after the time of operation. Partial autopsy, through the abdominal incision, showed the anastomosis to be intact. The lower abdomen contained a small amount of serous fluid. Five additional diverticula were discovered in the distal jejunum (Fig. 2); none of these showed any inflammatory process.

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BOOK REVIEWS

SURGERY OF NEOPLASTIC DISEASES BY ELECTROTHERMIC METHODS, by GEORGE AUSTIN WYETH, M.D. 8vo., pp. 298, illustrations 137. Paul B. Hoeber, Inc., New York, N. Y., 1926.

It is not surprising that in the present volume Doctor Wyeth has found it necessary to devote considerable attention to the question of terminology. Thus far no definite standard of this subject has been formulated and accepted. Each writer, through force of circumstance, has been compelled to create descriptive phrases of his own with the result that great confusion exists. To clarify this Doctor Wyeth suggests the term "*endothermy*," meaning "heat from within," since it is generated in the tissues within the body in response to the many oscillations of a high frequency current. It comprehends desiccation, coagulation and the endotherm knife. It excludes fulguration, electrolysis and cauterization. In character and in effect it differs radically from the transmitted heat of the electric or galvanocautery, the Paquelin cautery and the Percy cautery. In these last, heat is generated in the applicators themselves which are always *hot* when applied. The effect of such an application is to cauterize or burn the tissues. The sharp-pointed active electrode in endothermy is always *cold* when applied, and the heat which is generated in the tissues does *not* char or burn. Unskilful users of endothermy have produced charring, but only as a result of the employment of a faulty technic. This distinction between a hot and a cold applicator is an extremely important one and should be continually borne in mind when this new form of surgical treatment is considered.

Another suggestion of great practical importance is that the word "*endothermy*" be used to indicate the *surgical* application of high frequency currents, and that "*diathermy*" be limited to the *medical* application of the same type of electricity.

Briefly stated *endothermy* comprises the use of monopolar high frequency currents, of bipolar high frequency currents and of the endotherm knife. This last form of the use of electricity is the important contribution which Doctor Wyeth has personally made to this field of operative surgery. By the use of a three-element vacuum-tube a current is produced which has a cutting effect on the tissues, seals lymphatics as it cuts, checks all ordinary hemorrhages as the needle advances and gives immeasurably greater protection from the dangers of metastasis and recurrence than the scalpel can provide.

A knowledge of the history of high frequency currents is essential if we are to intelligently understand the basis upon which Doctor Wyeth's progress has been founded. "Galvanism," "faradism," the "volt," the "ampere," the "ohm," the "dynamo" and the "motor" are terms in common usage for the past thirty years. The term "high frequency current" is of relatively recent origin and dates from about 1891 when D'Arsonval showed that mus-

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cular contractions cease with 10,000 oscillations per second. This number has therefore been taken arbitrarily as the dividing line between currents of high frequency and those of low frequency. Investigators also showed that if a high frequency current of three amperes was passed through the body no other sensation than that of *heat* was produced. To this effect of the *passing of heat through the body* the name *diathermy* was applied.

All of these earlier operators used a high frequency current of a relatively low rate of oscillation. The most important advance in the very recent history of the high frequency current was that of Lee de Forest, who modified the Fleming tube by adding a sieve-like electrode or grid between the hot and the cold electrodes. This acts as an amplifier, which permits, with but a very small amount of energy, the variation and control of a many times larger amount of energy across the space between two electrodes.

This device of de Forest has made possible the perfection of the endotherm's cutting current which Doctor Wyeth describes as the "endotherm knife." The short spark thus produced increases the number of oscillations in the high frequency current so that now with the new apparatus as high as 6,000,000 oscillations per second appears to have been produced. A needle point with these short sparks concentrated upon it, if drawn across a tissue causes it to fall apart as if split by a knife. This needle point arc not only forms a scalpel that cuts like any other knife, but it also has the advantage of sterilizing the wound.

An important contribution to the present volume is the section written by Dr. A. Mutscheller, physicist, upon the principles governing the production of high frequency currents. This highly technical subject is presented with a clarity which will be appreciated by the reader for it enables him to understand the essentials of the method by which this tremendous increase in high frequency oscillations has been produced.

Monopolar endothermy is the form of current most frequently used. It is the lightest or dessicating current and is especially applicable to a wide range of superficial lesions, cancerous or precancerous, which have extent without deep involvement. Warts, moles, nevi, tattoo marks, caruncles and similar lesions may be removed by this method in a single treatment without pain or hemorrhage. An ordinary sewing needle held in a suitable handle is employed and just sufficient heat is produced in the tissues to cause a local dehydration. So delicate is the adjustment of the apparatus that a pin-point area on the cornea of the eye or a spot on the vocal cords may be removed by the lightest touch. This method is not "sparking" (fulguration); there is always a *contact* in endothermy. The electrode is cold, the dehydrating heat is formed within the tissues themselves by their resistance to the current. The only spark during the destruction is that formed as the electrode is withdrawn.

Bipolar endothermy, the method of using the deep, penetrating, coagulating D'Arsonval current of comparatively low voltage and high amperage, greatly extends the usefulness of high frequency currents in the treatment of

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accessible neoplastic disease. The ordinary steel sewing needle is the most satisfactory electrode and the heat which is generated within the tissues is produced by connecting one pole of the apparatus to a well wet indefinite electrode placed under the patient's buttocks as he lies upon the table. The cold needle is the electrode of contact. Local or general anaesthesia is used and before the area of malignancy is touched the needle is introduced to the necessary depth and passed completely around the malignant area *within the healthy tissue*. By this means not only are blood and lymphatic vessels sealed but the sensory nerves also are severed. This results in the prompt alleviation of pain which is one of the remarkable features of endothermy. There is no smoke and no heat conducted to the surrounding healthy tissue which simply turns white along the line of the needle. With this powerful current an untrained operator can do great harm. It is a surgical weapon to be handled with great caution.

While it is true that the idea of an electric current of cutting power did not originate with Doctor Wyeth, it is also true that the methods used before the perfection of the *endotherm knife* by the author were essentially experimental and elementary. The introduction of the three-element vacuum tube was the important link in the chain for which Doctor Wyeth is responsible. The frequency of oscillation thus produced is so extremely high that it causes a molecular dissolution of the tissues, sealing the lymphatics as it cuts by a thin line of coagulation. If the operation be properly performed the incision heals by primary union. The resulting scar is thinner, finer and less conspicuous than when the scalpel is used.

The application of endothermy to lesions of the mucous membrane are described in several interesting chapters. The lips, the tongue and various cancerous conditions of the buccal cavity are of chief importance. Leucoplakia, epulis, ranula, tonsillectomy and the malignant growths of the larynx are all considered.

The rectum is also accessible. Hemorrhoids, both external and internal, as well as anal fissures and fistulas, are satisfactorily operated by the same method. The mucous membrane of the uterus, the urethra, the vulva and the bladder are equally accessible, and caruncles, ulcers and carcinomata were thus treated successfully after various other forms of treatment had been tried and failed.

Endothermy as applied to lesions of the skin is the most important section of the book for practical purposes. The area is so much more extensive and the variety of lesions, both benign and malignant, is so great, that, in this domain, the importance of endothermy becomes of the greatest value.

HENRY P. DE FOREST.

THE SURGERY OF CHILDHOOD. By JOHN FRASER, F.R.C.S.E. Regius Professor of Clinical Surgery in the University of Edinburgh. In two volumes. New York, William Wood and Company, 1926.

This work on Surgery of Childhood appears in two volumes, well bound,

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plainly printed on good paper and profusely illustrated. The work is very comprehensive and inclusive, covering every conceivable surgical condition to which childhood may be heir. Surgical tuberculosis is given by far, more space than any other one disease. Nearly every bone and joint is taken up separately and fully discussed with reference to this disease. The history, anatomy, pathology, physical and X-ray findings, diagnosis and treatment are all given in minute detail.

It is interesting to note that in the chapter on transfusions and infusions the author believes firmly that the use of citrated blood for transmissions is the method of choice in all cases, in spite of the fact that in this country surgeons are using more and more frequently some one of the direct methods. In the chapter on surgery of the abdomen the technic of the operative procedures is not given. This omission is more or less prevalent throughout the work.

The author in his preface offers apologies for the length of the production. True, at times, when reading the work throughout, there is apparently unnecessary recapitulation, but used as a reference book, and for such it was undoubtedly written, this repetition is not noticed.

The basis of the work is formed by lectures and clinics given at the Edinburgh Royal Hospital for Sick Children. The substance of these lectures and demonstrations has been adapted to make them suitable for publication. Illustrations and references have been pertinently supplied. The work is recommended not only to the general surgeon and to the orthopaedist, but because of its attention to diagnosis, to the general practitioner as well.

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